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Traffic safety culture among bicyclists– results from a Norwegian study

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Abstract
This paper reports results from a study of traffic safety culture (TSC) among bicyclists (N=231) in Oslo, Norway. The aims of the study are to examine whether respondents' TSC in relation to bicycling is related to the TSC of their peers, and whether respondents' TSC influences their bicycle accident risk. The study measures TSC among bicyclists as a set of interrelated bicycle safety behaviours and –attitudes that are shared in groups. This study focuses on peer groups, which are operationalized as respondents' closest friends and colleagues. Results indicate that respondents' TSCs are associated with those that they ascribe to their peers, and that respondents' bicycle safety behaviours predict their bicycle accident risk. As respondents' bicycle safety attitudes not predicted their bicycle accident risk, the role of bicycle safety attitudes as a component of TSC is discussed. Although we have only measured TSC that respondents ascribe to their peers, the study could indicate that TSCs related to bicycling are shared in peer groups. Although more research is needed, the study suggests that the TSC perspective can be applied to non-professional road users in general, and specifically vulnerable road users like bicyclists. Implications for traffic safety interventions are discussed.

Key words:

Traffic safety culture; safety culture; traffic safety; bicycle; bicyclists; bicycle safety culture.

1. Introduction

Traffic accidents represent a serious public health problem. 1.3 million people die worldwide each year as a result of injuries from traffic accidents, while approximately 50 million people are injured (IRTAD, 2010). Studies show that the accident risk related to bicycling is considerably higher than it is for car drivers and pedestrians (Bjørnskau 2005, 2011). Several bicycle accidents are not reported to the police. However, according to Statistics Norway, police reports indicate that 509 people were injured and that 12 people were killed in bicycle accidents in Norway in 2012. Still, bicycle risk in Norway is low compared to most countries, being similar to the risks in the safest bicycle countries, The Netherlands and Denmark (Pucher & Buehler, 2008; Bjørnskau 2003; 2008).

Research also shows that one of the most important factors predicting cyclists' accident risk is their bicycle safety behaviours (Bjørnskau 2001, 2005).

It has been argued that new approaches are required to further reduce the number of road accidents and injuries. Although safety culture traditionally applies to organizations, recent research suggests that the safety culture perspective may have great potential for improving traffic safety, (cf. AAA Foundation for Traffic Safety, 2007; Johnston, 2010; Ward et al., 2010). The context of non-professional road users is, however, different from the organizational context, as non-professional road users are not culturally bonded by organizational units.

In a previous study we therefore set out to examine whether the (traffic) safety culture perspective can be applied to other analytical units than organizations (Nævestad & Bjørnskau 2012). Three alternative analytical units were discussed: 1) local communities, 2) nations, and 3) peer groups. We concluded in favour of applying the traffic safety culture (TSC) perspective to peer-groups, as suggested by Ward et al (2010) (Nævestad and Bjørnskau 2012).

The present paper applies the TSC perspective to peer-groups, focusing on bicyclists. The study reports results from a study of TSC among bicyclists (N=231) in Oslo, Norway. The aims of the study are to examine whether respondents' TSC in relation to bicycling is related to the TSC of their peers, and whether respondents' TSC influences their bicycle accident risk.

Most definitions of organizational safety culture specify it as safety relevant behaviours and/or attitudes that are shared in groups (Antonsen 2009; Nævestad 2010). Thus, this study measures TSC in relation to bicycling as a set of bicycle safety behaviours with associated bicycle safety attitudes, which are shared in groups. Bicycle safety behaviour items were based on bicycle safety behaviours found to predict accident risk in previous studies (Bjørnskau 2001, 2005). Bicycle safety attitudes were defined as perceptions of hazard and responsibility related to some of these behaviours. Indexes are constructed for both behaviours and attitudes. Peer-groups/peers are operationalized as respondents' closest friends/colleagues.

In accordance with previous research, we first expect background variables like e.g. age, sex and education to be associated with bicycle safety behaviour, bicycle safety attitudes and bicycle accidents involvement (Bjørnskau 2005). Second, we expect car use, i.e. years of car license and regular car use to be associated with bicycle safety behaviours, -attitudes and accident risk, as these variables involve comprehensive traffic training and -experience (Bjørnskau 2005). Third, we also expect bicycle type and cycling frequency to be associated with bicycle safety behaviour, bicycle safety attitudes and bicycle accidents involvement (Jaques 1994; Bjørnskau 2005).

Fourth, in accordance with previous research, e.g. the theory of planned behaviour (TPB) we also expect respondents' bicycle safety behaviours to be associated with their bicycle safety attitudes (Ajzen 1991; Kakefuda; Stallones & Gibbs 2009), and peers' bicycle safety attitudes (Lajunen & Räsänen 2001, 2004; Jaques 1994). Moreover, in line with previous research like e.g. the social norms approach (Berowitz 2005) and other research on the normative influence on bicycle safety behaviour, we expect respondents' bicycle safety behaviours to be associated with their peers' bicycle safety behaviours (Lajunen & Räsänen 2001, 2004; O'Callaghan & Nausbaum 2006; Coron, McLaughlin & Dorman 1996). This also applies to respondents' susceptibility to peers' opinions about their bicycling, which also has been referred to as "motivation to comply" (Kakefuda; Stallones & Gibbs 2009).

Fifth, we expect a relationship between bicycle safety attitudes and peers' bicycle safety attitudes (Kakefuda et al 2009). Although we have not seen research on the issue, we also examine the association between bicycle safety attitudes, peers' bicycle safety behaviours and respondents' susceptibility to peers' opinions about their bicycling, to shed light on potential variables associated with bicycle safety attitudes.

Sixth, we also expect respondents' bicycle accident involvement to be associated with their bicycle safety behaviours (Bjørnskau 2001, 2005). We also examine whether bicycle safety attitudes influence bicycle accident involvement, as this relationship has been focused on in studies of traffic accidents and traffic (Rakauskas, Ward & Gerberich 2009). Although we have not seen research on the issue, we also examine the association between respondents' bicycle accident risk and their peers' bicycle safety attitudes and peers' bicycle safety behaviours.

The expected relationships are examined in regression analyses using three different dependent variables: traffic safety attitudes index, traffic safety behaviour index and bicycle accidents.

2. Theoretical approach

2.1 Organizational safety culture and -climate

The concept of organizational safety culture is usually traced to the 1986 Chernobyl disaster, which made the International Nuclear Safety Advisory Group (INSAG) conclude that an inadequate safety culture at the plant was an important cause of the accident (INSAG, 1991). In the years following the disaster, several major accident investigations have identified safety culture as a major contributing factor. The concept of safety climate is closely related to that of safety culture. Safety climate can be conceived of as "snapshots", or manifestations of safety culture (Cox & Flin 1998). Safety culture is generally measured by means of safety climate questionnaires (Guldenmund, 2000).

2.2 Traffic safety culture

The concepts of safety culture and climate have only recently been applied in studies of professional drivers in road transport (e.g. bus drivers, taxi drivers, van drivers and truck drivers) (cf. DfT, 2004; Wills, Biggs and Watson, 2005; Davey et al., 2006).

Studies of organizational safety culture and safety climate among professional (or work-related) drivers in road transport often combine organizational safety culture or climate questionnaires with questionnaires measuring self-reported driving behaviours (e.g. the Driving Behaviour Questionnaire-DBQ), perceptions of risky behaviours, attitudes to various traffic safety interventions targeting risky behaviours, self-reported accidents, and so forth (e.g. Davey, Freeman and Wishart, 2006). In these studies, a relationship between organizational safety culture, professional drivers' traffic safety behaviours and accident risk has been found (e.g. DfT, 2004, Davey, et al. 2006).

The safety culture of non-professional drivers in road transport has also been given attention in recent years. This line of research also focuses on self-reported driving behaviours, perceptions of risky behaviours, and attitudes to traffic safety interventions (e.g. Rakauskas, Ward & Gerberich. 2009). Rakauskas et al (2009) explain differences in regional accident risks in light of differences between rural and urban TSCs. Girasek (2013) assesses to what extent public attitudes and behaviours support traffic safety advancement in the United States, and she concludes that support for traffic safety is not uniform across topics or population subgroups. Page (2001 in Ward et al 2010) explains differences in the traffic fatality rates of different countries in light of differences in national TSCs. In a US white paper[1] dedicated to TSC, Ward et al. (2010) states that:

> Traffic safety culture appears to be an intuitive and powerful concept with which to explain observed differences in international, regional and demographic crash risks, as well as the propensity to commit high risk behaviors. If it is possible to define and apply this concept within a relevant social psychological theory of behavioral choice, it may be possible to develop a new paradigm for traffic safety interventions. (Ward et al., 2010: vii)

Since non-professional road users are not culturally united by organizations, shared traffic safety behaviours, -perceptions and -attitudes must be ascribed to other social units than organizations. There is no consensus as to which groups this should be, but different alternatives have been suggested and examined, e.g. regions, nations, local communities, peer groups (Rakauskas et al 2009; Page 2001 in Ward et al 2010; Wiegman et al 2007; Ward et al 2010).

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[1] As part of an effort to develop a US National Strategy on Highway Safety, nine white papers were prepared to highlight key issues. The second white paper dedicated to traffic safety culture (Ward et. Al 2010). This white paper is a draft dated July 7, 2010.

2.3 Traffic safety culture applied to the analytical unit of peer groups

As noted, previous studies have suggested applying the concept of TSC to the social unit of peer groups (Ward et al. 2010; Nævestad & Bjørnskau 2012). Accordingly, Ward et al. (2010) define TSC as:

> (…) perceptions people have about what behaviors are normal in their peer group and their expectations for how that group react to violations to these behavioral norms. In terms of traffic safety, this definition applies to behaviors that either increase risk (e.g. speeding) or are protective (e.g. wearing seatbelts), as well as behaviors related to acceptance or rejection of traffic safety interventions. (Ward et al., 2010: 4-5)

The Penguin dictionary of sociology (1994: 312) defines peer group as: "(...) any collectivity in which the members share some common characteristics such as age or ethnicity." The dictionary also stresses that peer group often refers to adolescent groups where members are closely bound together by youth culture. Ward et al. (2010) do not define peer group, although they treat peer groups as social groups of people sharing an identity.

2.4 Normative influences on behaviour

How an individual's peer group membership influences their behaviour has been studied in a number of different research fields. Peer group membership influences individuals' behaviours through both direct social pressures and more subtle social mechanisms. We may refer to such social pressures as normative influences on behaviour (Cialidini, Reno & Kallgren 1990). Individuals' perceptions of peers' opinions (i.e. approval/disapproval) about a given behaviour are often defined as injunctive norms, while individuals' perceptions of what peers actually do often are defined as descriptive norms (Ajzen 1991; Rivis & Sheeran 2003; Ward et al 2010). While descriptive norms specify what is actually done, injunctive norms specify what ought to be done; beliefs regarding what constitutes morally approved and disapproved conduct (Cialdini et al 1990: 1015). It is important not to mistake the mechanisms of injunctive and descriptive norms, preceding behaviour, with the "false consensus" mechanism, following behaviour. This is a cognitive bias meaning that individuals overestimate certain behaviours among others in other to justify their own behaviour (Berkowitz 2005).

Different strands of social psychologial research focus on normative influences on behaviour. Cialdini et al (1990), and Berkowitz (2005) are proponents of the social norms theory, which uses knowledge about normative mechanisms to construct campaigns aiming at changing behaviour (Berkowitz 2005). This approach is based on the descriptive norms mechanism, and the idea behind this approach is to remove false consensus effects supporting risky behaviour by informing risk groups about the actual prevalence of risky behaviour of their peers (Berkowitz 2005; Linkenbach & Perkins 2005).

The focus on normative influences on behaviour is also important in the theory of planned behaviour (TPB) (Ajzen, 1991, 2006), and in the critique of it (Rivis &

Sheeran 2003). In short, TPB predicts that our behaviour is the result of our intention to carry out the behaviour, and that our intention to carry out a particular behaviour is influenced by our attitudes towards the behaviour, injunctive norms and our perceived control over our behaviour (Ajzen 2006; Ajzen 1991). It has been claimed that TPB to some extent fails to take more subtle forms of social influences into account. As a consequence the concept of descriptive norms was coined in the model as a variable influencing intentions (Rivis & Sheeran 2003). The concept of descriptive norms has been incorporated into TPB in recent years (Forward 2009).

2.5 Normative influence on bicycle safety behaviour

Research shows that descriptive and injunctive norms influence traffic safety behaviours (e.g. Haglund & Åberg 2000; Forward 2009; Backer-Grøndahl 2009). This also applies to bicycle safety behaviours (Kakefuda, Stallones & Gibbs 2009, Lajunen & Räsänen 2001, 2004, O'Callaghan & Nausbaum 2006). Several studies, both among teenagers and adults have found that positive attitudes to bicycle helmet wearing among peers (injunctive norms) or helmet wearing among peers (descriptive norms) increase the likelihood of helmet use (e.g. Coron, McLaughlin & Dorman 1996, Everett, Price, Bergin & Groves 1996, Jaques 1994).

Lajunen and Räsänen (2001) investigate why teenagers choose not to use bicycle helmet even when they have one. They study 965 high school students, and their analysis of bicycle helmet owners' propensity to use helmets conclude that having friends who use bicycle helmets (descriptive norms) was strongly related to using helmets. Second they also found that parents positive opinions on helmet use (injunctive norms) predicted helmet use frequency.

In a later study, Lajunen and Räsänen (2004) discusses the health belief model (HBM), theory of planned behaviour (TPB) and locus of control model (LC) in understanding the intention to use helmet among helmet owners. They conclude that the TPB and LC fitted the data well. They found that subjective norm was the strongest predictor of the intention to use a helmet, usually referring to the positive attitudes of parents and friends of the high school students (N=965) in their study.

O'Callaghan and Nausbaum (2006) study helmet wearing intentions and behaviour among adolescents (N= 294). They found that helmet use was predicted by perceived control and past behaviour, while helmet use intentions were predicted by subjective norm, perceived control and past behaviour. Examining differences between helmet users and non-users, they found that users believed more strongly than others that significant others (e.g. best friends) used helmets (descriptive norms) and that these referent groups would approve of their helmet use (injunctive norms).

Kakefuda Stallones and Gibbs (2009) examine associations between bicycle helmet use and attitudes among U.S. college students (N=192). They study helmet use in two different settings: commuting to school and recreational bicycling.

They found that less than 10 % used helmets every time for commuting, while 36.5 % did so for recreation. Respondents who did not use helmets reported that they did not because they believed it was not necessary on short distances and as they believed helmet use to be inconvenient. Thus, this study shows that peoples' helmet use also is dependent on purpose and the setting of bicycle trips.

3. Method –survey of bicyclists

3.1 Sample

A web-based survey was distributed to 1600 people working in a research park environment made up of 160 different companies and research organizations sharing infrastructure in the fall of 2011.[2] The research park environment is located in Oslo, which is the capital of Norway. Each of the 1600 people who were introduced to the survey got an e-mail from the research park administration. The subject of the e-mail was "Do you bicycle?" and the e-mail contained a link to the survey, and the following description of the survey:

> "All bicyclists in the research park (regardless of level of activity and competence) are encouraged to complete a survey. In this way you may support our research. Additionally, you may participate in a draw for a present card of 2000 NOK (Provided that you give your name. You may refrain from giving your name if you want to maintain your anonymity)"

246 people participated in the survey, but 15 of these respondents were excluded from the sample, since they reported that they bicycled less than once a month. It is assumed that TSC related to bicycling emerges through regular bicycling, involving interaction with other road users (cf. Nævestad & Bjørnskau 2012). Consequently, the study includes 231 respondents. Based on the 1600 people who were introduced to the survey this gives a response rate of about 15 %. This estimate is, however, incorrect as the e-mail and the survey is aimed only at the bicyclists among the 1600 people. We do not know the actual share of bicyclists in this population, and thus we neither know the actual response rate of our study.

3.2 Survey measures

The following background variables are included in the study: age, sex, country of birth, car driver's licence, years of car drivers' license, frequency of car driving, education, income, bicycle type, bicycle use in the summer and in the winter. 17 questions measuring respondents' bicycle safety behaviour and bicycle safety attitudes were included in the survey. 20 questions about the bicycle safety behaviours and bicycle safety attitudes of respondents' referent individuals were

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[2] The Institute of Transport Economics, which is the place of work of the authors, is one of the institutions sharing this infrastructure.

also included in the survey. The survey included 6 questions measuring how much respondents care about their referent individuals' opinions about their cycling, for instance whether they use a helmet, cycle without lights in the dark, or under the influence of alcohol. The survey also included questions about bicycle accident involvement, where respondents bicycle, and respondents' purposes of their bicycle trips (e.g. job or exercise), conflicts with other road users and bicyclist identity. It is beyond the scope of this paper to report the results of all of these questions.

3.3 Questions about bicycle safety behaviour and bicycle safety attitudes

The survey includes eight questions about bicycle safety behaviour. These questions are based on bicycle safety behaviours found to predict accident risk in previous studies (Bjørnskau 2001, 2005). Respondents were invited to answer these questions using a 5-point scale, cf. table 1

Table 1 Questions and answer alternatives: bicycle safety behaviour

Questions used to measure bicycle safety behaviour.
Answer alternatives: 1= never, 2=seldom, 3=sometimes, 4=often, 5= always. **How often do you:** 1) Use a helmet when you bicycle? 2) Use a light on the bike when you bicycle in the dark? 3) Bicycle when you know or are unsure, whether you are under the influence of alcohol? 4) Ignore red lights when there are no other road users around? 5) Put your arm out to signal when you are turning left and there are cars nearby. 6) Step off the bike when you are crossing the road using zebra crossings. 7) Try to establish eye contact with car drivers in intersections 8) Take for granted that car drivers you pass on the inside (right side) are unaware of you.

A bicycle safety behaviour index was computed based on these eight questions. The index is computed as the average score of the questions. Question 3 and 4 were negatively worded, and were reversed in the analysis. The internal consistency of the bicycle safety behaviour index was somewhat low (Cronbachs's alpha = 0,599). Although this is lower than the conventional minimum of 0,7, we chose to use this index as the questions have predicted accident risk in previous studies (Bjørnskau 2001, 2005).

The study includes six questions about bicycle safety attitudes. These were formulated as questions regarding how respondents would experience bicycling without wearing a helmet, bicycling without lights in the dark and bicycling under the influence of alcohol (irresponsible, dangerous).

Respondents were invited to answer these questions using a 5-point scale, cf. table 2.

Table 2 Questions and answer alternatives: bicycle safety attitudes

Questions used to measure bicycle safety attitudes.
Answer alternatives: 1= totally disagree, 2=disagree somewhat, 3=neither, nor, 4=agree somewhat, 5= totally agree. **Riding a bicycle without wearing a helmet would usually feel:** **Bicycling without lights in the dark would usually feel:** **Bicycling under the influence of alcohol would usually feel:** 1) Irresponsible 2) Dangerous

A bicycle safety attitude index was computed on the basis of these questions. The survey originally included nine questions about bicycle safety attitudes, but three questions regarding a third alternative, “3) Comfortable”, were removed, in order to achieve a higher internal consistency. The new bicycle safety attitude index consisting of six questions got a Cronbachs’s alpha of 0,759. The index consists of six questions, as it is made up of three questions which are assessed in light of two alternatives (i.e. “irresponsible”, “dangerous”).

3.4 Questions measuring respondents’ care about other peoples’ opinions about their bicycle safety behaviours

The survey includes six questions measuring how much respondents care about other peoples’ (parents, spouse/girlfriend/boyfriend, closest female friends, closest male friends, colleagues, other significant people) opinions about their cycling, for instance whether they use a helmet, cycle without lights in the dark or under the influence of alcohol. The questions and answer alternatives are presented in table 3.

Table 3 Questions and answer alternatives: respondents’ concern about other peoples’ opinions about their bicycle safety behaviours

Questions used to measure respondents’ concern for the opinions of other people
Answer alternatives: 1= very little, 2=quite little, 3=neither, nor, 4=quite much, 5= very much. **As a bicyclist, to what extent do you care what other people think? (e.g. if you ride a bike without a helmet, under the influence, without lights in the dark):**

1) Parents 2) Spouse/boyfriend/girlfriend 3) Closest female friends 4) Closest male friends 5) Colleagues 6) Other people that are important to you (relatives, leaders, politicians, celebrities and so forth)

An index concerning respondents' concern about other peoples' opinions about their bicycle safety behaviours was computed based on these six questions. The index is computed as the average score of the questions. The internal consistency of the index was high (Cronbachs's alpha = 0,907).

We included these questions to identify the people that respondents cared most about the opinions of, and to distinguish between respondents who care about the opinions of other people and respondents who care less about the opinions of others.

3.5 Questions measuring respondents' perception of their peers' bicycle safety behaviour and attitudes

3.5.1 Respondents' perception of peers' bicycle safety behaviour

The survey included 10 questions about respondents' assessments of the bicycle safety behaviour of other people. We could also refer to these assessments as descriptive norms, as they concern respondents' assessments of peers' (un)safe bicycle behaviour (Cialdini et al 1990). Respondents were invited to answer these questions using a 6-point scale, cf. table 4.

Table 4 Questions and answer alternatives: respondents' perception of other peoples' bicycle safety behaviour

Questions used to measure respondents' perception of other peoples' bicycle safety behaviour.
Answer alternatives: 1= none/very few, 2=less than half, 3=about half, 4=more than half, 5= nearly all/all (6= do not know: this alternative was removed in the analyses) **Approximately how many of the following people do you think use a helmet when they bicycle?** 1) closest female friends, 2) closest male friends, 3) colleagues, 4) parents, 5) people in Norway **Approximately how many of the following people do you think bicycle under the influence of alcohol?**

1) closest female friends, 2) closest male friends, 3) colleagues, 4) parents, 5) people in Norway

An index concerning peers' bicycle safety behaviour was computed based on the questions related to the behaviour of closest female/male friends and colleagues. The internal consistency of the "peers' bicycle safety behaviour index" was acceptable (Cronbachs's alpha = 0,779). The index is computed as the average score of the questions.

"People in Norway" was not included in the index, as this question was included in the survey to examine false consensus effects. Moreover, this social unit is too general to be included in respondents' peer groups. "Parents" could perhaps have been included, but was not included in the index, as several respondents used the free text field to comment that they do not know how their parents bicycle, that their parents do not bicycle at all, or that their parents are deceased. The internal consistency of the scale did not change when "parents" was removed.

3.5.2 Respondents' perception of peers' bicycle safety attitudes

The survey includes 10 questions about respondents' assessments of the bicycle safety attitudes of other people. We could also refer to these assessments as injunctive norms, as they concern respondents' assessments of peers' opinions on their (un)safe bicycling (Cialdini et al 1990). Respondents were invited to answer these questions using a 5-point scale. The questions and answer alternatives are presented in table 5.

Table 5 Questions and answer alternatives: respondents' perception of other peoples' bicycle safety attitudes

Questions used to measure respondents' perception of other peoples' b
Answer alternatives: 1= to a great extent, 2=to some extent, 3=to a little extent, 4=not at all (5= do not know: this alternative was removed in the analyses)
To what extent do you think that the following people will find it irresponsible of you to bicycle without a helmet?
1) closest female friends, 2) closest male friends, 3) colleagues, 4) parents, 5) spouse/girlfriend/boyfriend
To what extent do you think that the following people will find it irresponsible of you to bicycle under the influence of alcohol?
1) closest female friends, 2) closest male friends, 3) colleagues, 4) parents, 5) spouse/girlfriend/boyfriend

In accordance with the lines of argument pursued above, an index concerning peers' bicycle safety attitudes was computed based on the six questions related to the behaviour of closest female/male friends and colleagues. Spouse/girlfriend/boyfriend was taken out, as this was not included in the preceding behaviour index. The internal consistency of peers' bicycle safety attitudes index was fairly high (Cronbachs's alpha = 0,817). The index is computed as the average score of the questions. The items were reversed to match the positive direction of the other indexes.

4. Results

4.1 Respondents' characteristics

Table 6 presents respondents' characteristics on some of the key variables in the study.

Table 6 Respondents' characteristics on key variables, mean/percentages, standard deviation and minimum and maximum values

Variable	M / % (SD)	Min-Max
Age	42.68 (11.141)	24-74
Sex (Female)	39 %	
Country of origin (Norwegian)	87.7	
Education (5-6 years at university)	83.1 %	
Car drivers license (Yes)	93.9 %	
Years with car drivers licence	22.8 (10,93)	0-50
Drive car (once a week or more)	57.7 %	
Income (Nok 500 000, or more)	58 %	
Bicycle safety behaviour index	3,7793 (0,56806)	1,5-4,88
Bicycle safety attitudes index	3,8966 (0,6719)	1-5
Resp. care for others' op. index	2,6801 (0,94082)	1-4,83
Peers' bicycle safety behaviour	3,5079 (0,8326)	1-5
Peers' bicycle safety attitudes	2,7176 (0,5721)	1,17-4
Bicycle type:		
Off-road	42 %	
Hybrid	39,4 %	
Classic	11,7 %	
Racer	2,6 %	
City	3,9 %	
Other bike	0,4 %	
Bicycle use in the summer:		
Every day	36,6 %	
Several times a week	39,7 %	
Once a week	6,1 %	

Several times a month	4,6 %
Once a month	0,8 %
Bicycle use in the winter:	
Every day	11,3 %
Several times a week	13 %
Once a week	1,7 %
Several times a month	5,6 %
Once a month	5,2 %
Accident involvement in the last three years:	
No	69,3 %
Yes, but no injuries	11,7 %
Yes, with material injuries	7,4 %
Yes, with personal (and material?) injuries	11,7 %

The sample consists of 61 % males, the average education level is very high with more than eighty per cent holding a major university degree. The fact that the respondents were recruited among the employees at the science park in Oslo may account for the high proportion of respondents with a university degree. Still, in Norway cyclists tend to be better educated than average.

In another survey conducted in Norway in 2012 with a sample of cyclist drawn from the membership registers of the Cyclist Federation and from the Falck bicycle register, more than 4000 cyclists participated with 1053 respondents from Oslo (Fyhri, Bjørnskau & Sørensen, 2012). Among the Oslo cyclists in this survey the average age was 45 years, 62 % were males and 67 % held a major university degree. Cycling frequency was slightly higher than in our survey, which is not surprising since this sample partly consisted of dedicated bicycle owners/users being members of the Norwegian Cyclist Federation.

The Norwegian National Travel Surveys also report bicycling to be more widespread among men and people with higher education. Thus, based on what we know about the cyclist population from other sources, we will conclude that our sample seems to be quite representative for the cyclist population in Oslo.

Table 6 indicates that most of the respondents usually bicycle on off-road bicycles, followed by hybrid bicycles and classic bicycles. The bicycle type categories have also been used in previous studies (e.g. Bjørnskau 2005, 2011), except for “city bikes”. “Off-road bicycle” refers to bicycles designed for off-road cycling. In English these bicycles are referred to as mountain bikes. Off-road bicycles generally have fat knotted tires (26, 27,5 29 inches), strengthened frames with suspension, more powerful brakes and several gears (e.g. 21-30). Off-road bikes invite to a leaning-forward sitting position. Hybrid bicycles are general-purpose bicycles mixing characteristics from touring bicycles, racing bicycles and mountain bicycles. These bicycles often invite to a leaning-forward sitting position and have several gears (e.g. 21-30). The hybrid bicycle has 28-inch tires which can be used both on gravel and asphalt. Classic bicycles refer to bicycles with a “traditional” or “classic” bicycle appearance, simple frame and tires (28 inches), few gears (3-7) if any, often baggage carriers and splash guards. Classic bicycles invite to an upright sitting position. Racing bicycles refer to lightweight bicycles designed for racing, with slick asphalt tires (28 inches), fewer gears than off-road bicycles (e.g. 15-20), inviting to a leaning-forward sitting position. “City bikes” are ad-financed bicycles for subscribers, available on different locations in the city. These bicycles have few gears (e.g. 7) and invite to an upright sitting position. In other countries, these can also be referred to as “bicycle sharing bicycles”. Norwegians refer to them as city bikes (“Bysykkel”). The final bicycle type is “other” types than the mentioned.

4.2 Respondents’ traffic safety culture

Table 6 shows that respondents’ mean score on the bicycle safety behaviour index was 3.78, and that the scores ranged from 1,5 to 4.88. Thus, this indicates that respondents on average nearly are often “(value 4) safety oriented” when they bicycle. Respondents’ mean score on the bicycle safety attitude index was 3.9, indicating that respondents on average tend to “agree somewhat” that it would feel dangerous and irresponsible to bicycle without wearing a helmet, without lights in the dark and under the influence of alcohol. A bivariate correlation analysis shows a positive medium strong Peason’s Correlation of 0,476 between the bicycle safety behaviour index and the bicycle safety attitude index. This correlation is significant at the 0,01 level.

4.3 Respondents’ concern about the opinions of other people

As noted, the survey includes six questions measuring how much respondents care about other peoples’ opinions about their cycling. We may also refer to this as respondents’ susceptibility for injunctive norms. Results show that all groups, except spouse/boyfriend/girlfriend have a mean score below 3 (neither,nor). This indicates that on average respondents care little about the opinions of others. In contrast, respondents rate spouse/boyfriend/girlfriend with a mean score of 3.40, with a standard deviation of 1.25.

4.4 Results from regression models

In this section, we present results from regression analyses using three different dependent variables: traffic safety attitudes index, traffic safety behaviour index and bicycle accidents. In the two first analyses we have used hierarchical, linear regression analyses, where independent variables are included in successive steps. Tables of results present the standardized beta coefficients. The contributions of the different independent variables on the dependent variables can therefore be compared directly.

In the third regression analysis with bicycle accident as the dependent variable, we have used logistic regression analysis, as the dependent variable was made dichotomous. Odds ratios (exp (B)) are presented, and they indicate the risk, or the odds, for being involved in an accident when the independent variable increases with one value controlled for the effects of the other independent variables.

Of course, we cannot conclude about causality, as this is a cross-sectional and correlational study. We nevertheless use the term predict when we describe the regression analyses. Ideally, we would have measured attitudes and norms at one time point and behaviour at a later time point, which is often done when testing e.g. the TPB. However, even though you measure attitudes and behaviour at different time points, you cannot necessarily conclude about causality.

4.4.1 The bicycle safety attitude index as the dependent variable

Table 7 gives the results of seven regression models with the bicycle safety attitudes index as the dependent variable. The scores on this index vary between 1 and 5. A high value on the bicycle safety attitude index indicates safe bicycle attitudes.

Table 7 Linear regression. Dependent variable: bicycle safety attitudes index. Standardized beta coefficients.

Variables	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Age	0,090	-0,023	-0,022	-0,071	-0,084	-0,079
Sex (F=2)	0,005	0,056	0,051	0,109	0,123	0,124
Country of birth (Oth. country=2)	0,178	0,081	0,080	0,001	0,009	0,009
Education	-0,106	-0,052	-0,059	-0,038	-0,022	-0,026
Income	-0,014	-0,078	-0,083	-0,051	-0,052	-0,047
Car licence (Y=2)		-0,135	-0,137	-0,074	-0,012	-0,012
Years of car licence		0,171	0,194	0,193	**0,205***	**0,204***
Drive a car regularly (1-4)		0,111	0,083	0,055	0,048	0,046
Bicycle type (C.B=2)			-0,122	-0,066	-0,037	-0,034
Bicycle frequency - summer			-0,063	-0,018	-0,037	-0,038
Bicycle frequency - winter			0,034	0,031	0,052	0,053
Peers' bicycle safety behaviour index				**0,411*****	**0 ,319****	**0,323****

Peers’ bicycle safety attitudes index					**0,289*** **	**0,283*** **
Care about referent individuals index						0,028
Adjusted R^2	-.015	.004	-.003	.150	.218	.211

* p < 0,1 ** p < 0,05 *** p < 0,01

None of the background variables, car driving variables or bicycle type and frequency variables that are taken into the analysis in step 1, 2 and 3 contribute significantly in these models. This is contrary to our assumption that background variables would be associated with respondents' traffic safety attitudes.

In step 4, we see that respondents’ perception of peers’ bicycle safety behaviour contributes to their bicycle safety attitudes. This is the most important variable predicting respondents’ bicycle safety attitudes. The effect is positive and significant at the 0,01 level, indicating that the safer respondents perceive that their peers bicycle, the safer bicycle safety attitudes they have themselves, controlled for the other variables.

In step 5, we see that both respondents’ perception of peers’ bicycle safety behaviour and safety attitudes positively and significantly predicts the respondents own bicycle safety attitudes. In step 5, we also see that when we control for respondents' perception of peers' bicycle safety attitudes, the effect of the years of car license variable becomes significant at the 0.1 level. The effect is positive, indicating that the longer respondents have had their car license, the safer attitudes they have, controlled for the attitudes they ascribe to their peers.

The variable ”care about referent individuals index” does not contribute significantly in step 6, indicating that respondents concern about referent individuals opinions about their bicycling does not predict respondents’ bicycle safety attitudes.

The Adjusted R^2 indicates the amount of variance in the dependent variable that is explained by the independent variables in the model. In step 5 the Adjusted R^2 is 0.218 which indicates that the independent variables explain 22 per cent of the variance in the dependent variable. Thus most of the variation in the bicycle safety attitude index must be ascribed to other characteristics than those included as independent variables in our models.

4.4.2 The bicycle safety behaviour index as the dependent variable

Table 8 gives the results of seven hierarchical regression models with the bicycle safety behaviour index as the dependent variable. The scores on this index vary between 1 and 5. A high value on the bicycle safety behaviour index indicates safe bicycling.

Table 8 Linear regression. Dependent variable: bicycle safety behaviour index. Standardized beta coefficients.

Variables	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Bicycle safety attitude index	**0,397*** **	**0,383*** **	**0,370*** **	**0,357*** **	**0,276*** **	**0,246*** **	**,254*** **
Age		**0,162***	0,136	0,071	0,037	0,028	0,016
Sex (F=2)		0,003	0,021	0,061	0,092	0,099	0,097
Country of birth (Oth. country=2)		0,062	0,054	0,077	0,037	0,040	0,042
Education		0,004	0,023	-0,003	0,009	0,012	0,013
Income		0,011	-0,013	-0,047	-0,042	-0,044	-0,052
Car licence (Y=2)			0,008	0,041	0,075	0,093	0,094
Years of car licence			-0,049	0,011	0,021	0,028	0,024
Frequency of car driving (1-4)			**0,184** **	**0,205** **	**0,207** **	**0,209** **	**0,208** **
Bicycle type (C.B=2)				**-0,195** **	**-0,172** **	**-0,165** **	**-0,169** **
Bicycle frequency - summer				0,028	0,052	0,045	0,050
Bicycle frequency - winter				**0,189** **	**0,178***	**0,183** **	**0,183** **
Peers' bicycle safety behaviour index					**0,234** **	**0 ,216** **	**0,213** **
Peers' bicycle safety attitudes index						0,094	0,101
Care about referent individuals index							-0,060
Adjusted R^2	.151	.147	.156	.216	.255	.256	.253

* p < 0,1** p < 0,05 *** p < 0,01

Bicycle safety attitude is the strongest predictor of bicycle safety behaviour among the respondents. The bicycle safety attitude index contributes significantly in all the steps, although it contributes a bit less in step 5-7, compared with step 1-4. The variable respondents' perception of peers' bicycle safety behaviour index is the second strongest predictor of respondents' bicycle safety behaviour. The car driving frequency variable is the third most important predictor of respondents' bicycle safety behaviour. The bicycle frequency – winter variable is the fourth most important predictor of respondents' bicycle safety behaviour. The Adjusted R^2 is .25 in the best models, indicating that our independent variables explain 25 per cent of the variation in the dependent variable.

Age predicts bicycle safety behaviour significantly at the 0,1 level in step 2, indicating that the older respondents get, the safer they bicycle. This variable ceases to contribute significantly as other variables are taken into the analysis.

In the 3. step the frequency of car driving variable contributes significantly at the ,05 level, indicating that the more often respondents drive a car each week, the safer they bicycle. The effect of this variable becomes stronger as more variables are taken into the analysis.

In the 4. step, bicycle type and bicycle frequency in the winter is taken in, both contributing significantly at the 0,05 level. Bicycle type contributes negatively. The bicycle type variable was dichotomized, after an ANOVA test, which showed that the bicycle type with the lowest mean score on the bicycle safety behaviour index was city bikes. As noted, city bikes are ad-financed bicycles for subscribers, available on different locations in the city. In other countries, these can also be referred to as "bicycle sharing bicycles". In the dichotomized variable, city bike has the value 2, while other bike types have the value 1. Accordingly, the variable bicycle type contributes negatively in the analyses, indicating that respondents who usually ride city bikes generally ride in less safe ways than respondents riding other bicycle types.

The bicycle frequency – winter variable contributes positively in step 4, indicating that respondents bicycling in the winter cycle more safely than other bicyclist, controlled for several background variables.

In the 5. step, respondents' perception of peers' bicycle safety behaviour index is included in the model. Peers' bicycle safety behaviour index contributes significantly in step 5, 6 and 7. This indicates that the safer respondents perceive that their peers bicycle, the safer they bicycle themselves.

Respondents' perception of peers' bicycle safety attitudes index does not contribute significantly to respondents' bicycle safety behaviour, as we see in step 6. In step 7, the concern about referent individuals index is taken into the analysis. This index does not contribute significantly to the bicycle safety behaviour index, indicating that controlled for the other variables in the analysis, respondents' concern about referent individuals opinions about their bicycling does not predict respondents' bicycle safety behaviour.

4.4.2 Bicycle accidents as the dependent variable

Respondents were asked whether they had experienced a bicycle accident during the last three years. The answer alternatives were: 1=no, 2=yes, I had an accident, and I continued without any injuries or material damages, 3= yes, I had an accident, which resulted in material damages, 4= yes, I had an accident which resulted in personal injuries (and possibly also material damages).

A logistic regression analysis was conducted with bicycle accident as dependent variable. In this analysis, the accident variable was dichotomized, 0=no accident, 1= accident with and without damages/injuries. According to these criteria, 30.3 % of the respondents have experienced a bicycle accident in the last three years.

Table 9 presents the results of the logistic regression analyses with bicycle accidents as the dependent variable. Odds ratios (exp (B)) are presented and they indicate the risk, or the odds, for being involved in an accident when the independent variable increases with one value, when the effect of the other independent variables in the step is controlled for.

Table 9 Logistic regression. Dependent variable: bicycle accidents (dichotomized: 0: no accident, 1=accident). Odds ratios (exp (B))

Variables	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Age	0,978	0,989	0,976	0,978	0,982	0,979	0,980
Sex (M=1)	1,245	1,234	1,016	1,024	1,008	0,955	0,992
Country of birth (Other country=0)	1,625	1,773	1,549	1,689	1,544	1,516	1,445
Education	1,113	1,018	0,868	0,885	0,891	0,945	0,933
Income	1,102	1,201	1,125	1,101	1,070	1,061	1,063
Car licence (N=1)		4,304	2,330	2,126	1,977	1,171	1,316
Years of car license		0,984	0,986	0,982	0,981	0,983	0,982
Drive a car regularly		0,976	1,120	1,102	1,212	1,206	1,194
Bicycle type (C.B.=0)			2,528	2,488	3,201	2,796	2,935
Bicycle frequency - summer			1,523	1,585	1,609	1,585	1,546
Bicycle frequency - winter			1,182	1,177	**1,234***	**1,260***	**1,261***
Bicycle safety attitude index				1,524	**1,967***	1,646	1,713
Bicycle safety behaviour index					**0,440***	**0,392****	**0,413***
Peers' bicycle safety att. index						2,062	**2,129***
Peers' bicycle safety beh. index							0,863

Nagelkerke R^2	.028	.047	.122	.139	.173	.197	.199

* $p < 0,1$ ** $p < 0,05$ *** $p < 0,01$

None of the variables in step 1-4 contributes significantly to respondents' bicycle accident risk. This applies to the general background variables, car driving variables, bicycle frequency variables and the safety attitude index.

In step 5, three variables contribute significantly, at the 0.1 level. The first is winter bicycling which increases the risk of having had a bicycle accident. This variable contributes also in the other steps in table 9. In step 7, we see that when the bicycle frequency – winter increases with one value, the odds of being involved in a bicycle accident increases with a factor of 1.26 The more you bicycle in the winter, the higher your risk of having a bicycle accident. This is not surprising. The accident risk related to winter bicycling is probably due to the fact that the road surface is slippery in winter.

The second variable contributing significantly in step 5 is the bicycle safety behaviour index, which contributes negatively and significantly to bicycle accident involvement with a value of 0.44. This means that when the bicycle safety behaviour index increases with one value, the risk of being involved in a bicycle accident decreases with a factor of 0.44. Thus, the safer you bicycle, the lower is your accident risk. This effect is also evident in the other analyses in table 9, although the effect is 0.413 in step 7.

The third variable contributing significantly in step 5 is the bicycle safety attitudes index. The effect of this variable was not significant in the preceding step, but it becomes significant when bicycle safety behaviour is taken in. Surprisingly the bicycle safety attitude increases the odds of having an accident, while the bicycle safety behaviour decreases the risk. When all the other variables are controlled for (i.e. the risk related to your eventual winter bicycling and bicycle safety behaviour), the risk of being involved in a bicycle accident increases with an odds of 1.967 when the bicycle safety attitude index increases with one value. The effect of this variable is only significant in one model, and only at the 0.1 level. Thus, it might be a random effect.

In step 7, we see that the effects of the variables bicycle safety behaviours and – peers' bicycle safety attitudes are different. Peers' attitudes increases the odds of an accident, controlled for the other variables, while bicycle safety behaviours decreases the odds. A Pearsons r correlation analysis of the two variables shows, however that they are positively (0.164) and significantly (0.05) correlated, as we would expect (i.e. respondents with safe bicycle safety behaviours report that their peers have safe bicycle safety attitudes). Moreover, given this variable's significance level of 0.1 in step 7, this may be a random effect.

Additionally, the effect of peers' attitudes becomes significant when peers' behaviours is taken into the analysis, although the effect of the latter is not significant. As with respondents' bicycle safety behaviours and attitudes, in step 5, the effect of peers' bicycle safety behaviours and attitudes is different in step 7, when all the other variables are controlled for. The effect of the peers' bicycle safety behaviours variable is however, not significant, and the effect of peers' bicycle safety behaviours is only significant at the 0.1 level.

The Nagelkerke R^2 indicates the amount of variance in the dependent variable that is explained by the independent variables in the models. In step 7 in Table 9 the Nagelkerke R^2 is 0.199 which indicates that the independent variables explain 20 per cent of the variance in the dependent variable, bicycle accidents.

To sum up, table 9 largely shows that winter bicycling increases the accident risk, while safe bicycling decreases the accident risk. This is interesting, as table 7 showed that winter bicycling positively predicted the bicycle safety behaviour index.

5. Concluding discussion

5.1 Are respondents' traffic safety culture in relation to bicycling related to their peers?

The aims of the study were to examine whether respondents' TSC in relation to bicycling is related to the traffic safety culture of their peers, and whether respondents' TSC influences their bicycle accident risk.

First, we found that respondents' bicycle safety attitudes were predicted by their perception of both peers' bicycle safety attitudes and peers' safety behaviours. The former was expected, as it has been reported by Kakefuda et al (2009), referring to social processes in which safety attitudes are shared and reinforced among peers.. However, we found peers' bicycle safety behaviours to be the most important predictor of bicycle safety attitudes, followed by peers' bicycle safety attitudes.

Second, we found that respondents' bicycle safety behaviours were predicted by their perception of peers' bicycle safety behaviour, but not their perception of peer's bicycle safety attitudes. The former association was expected, as it has been reported in several other studies (e.g. Lajunen & Räsänen 2001, 2004; O'Callaghan & Nausbaum 2006). However, although it was expected (e.g. Lajunen & Räsänen 2001, 2004), we did not find a relationship between bicycle safety behaviours and peers' bicycle safety attitudes. Our results could indicate that descriptive norms in general is more closely associated with bicycle safety behaviours and -attitudes than injunctive norms. We also saw that descriptive norms was a stronger predictor of respondents' bicycle safety attitudes than injunctive norms.

Third, we found that respondents' bicycle safety behaviours were associated with their bicycle safety attitudes. We expected respondents' bicycle safety behaviours to be associated with their bicycle safety attitudes, as this is in accordance with TPB research (Ajzen 1991), and research on bicycle safety behaviours (e.g.

Kakefuda; Stallones & Gibbs 2009). In the regression analysis, we found that bicycle safety attitudes was the strongest predictor of bicycle safety behaviours.

Fourth, we did not find a relationship between respondents susceptibility to peers' opinions about their bicycling and the effect of peers' behaviour and attitudes. Other studies have found that respondents' propensity to be influenced by peers are dependent on their care for the opinion of others (Kakefuda, Stallones & Gibbs 2009). We therefore included measures of this in our study, but we did not find the expected association. This may be due to the fact that respondents on average reported to care little for the opinion of others, with the exception of their spouse/girlfriend/boyfriend, which had an average score of 3,4 (3=neither/nor). As noted this variable was taken out of the bicycle safety attitude index. As it was not included in the bicycle safety behaviour index, we took it out to be able to compare the effect of the two. The average score of spouse/boyfriend/girlfriend indicates that this is a significant other, which should be examined in future studies. However, this is only relevant for the respondents who are in a relationship.

Fifth, we did not find that background variables were associated with respondents' bicycle safety behaviour or -attitudes. This result is contrary to previous research (Bjørnskau 2005), and it could be a result of limited demographic variation among our respondents. However, Everett et al (1996) did not find background variables or bicycle frequency to predict helmet wearing, but as noted these authors found descriptive norms to predict helmet wearing.

Sixth, years of car license was associated with bicycle safety attitudes, while frequency of car driving and frequency of bicycling in the winter were associated with bicycle safety behaviour. We expected car license, years of car license and regular car use to be associated with bicycle safety behaviours, -attitudes and accident risk, as these variables involve comprehensive traffic training and -experience. It is not surprising that car license was not associated with the variables, as the other significant variable is based on the premise that respondents have a license.

As noted most of the respondents usually bicycle on off-road bicycles, followed by hybrid bicycles and classic bicycles. Although we expected bicycle frequency and -type to influence bicycle safety attitudes and bicycle accident involvement (Jaques 1994; Bjørnskau 2005), we did not find bicycle frequency and –type to be associated with bicycle safety attitudes. Other studies have found a relationship between bicycle type and bicycle safety behaviours. Jaques (1994), for instance, found that adult helmet use was positively predicted by riding in the streets and riding a racer type bike. In ANOVA tests, we found that the differences between the bicycle safety behaviour index scores of the different bicycle types were only significant at the 0,1-level. City bikes had the lowest mean score of 3,26, while off-road bikes had a mean score of 3,85, followed by hybrid bike (3,78), classic bike (3,73) and racing bike (3,54).

As the city bikes had the lowest bicycle safety behaviour score, the bicycle type variable was dichotomized in the regression analyses (other bicycle types=1, city bike=2). These analyses indicates that city bikes were significantly and negatively associated with bicycle safety behaviour. Respondents who usually ride city bikes generally ride in less safe ways than respondents riding other bicycle types. The regression analyses indicate however that peers' bicycle safety behaviours were more strongly associated with respondents' bicycle safety behaviours than bicycle types. The relatively modest importance of bicycle type in our study could be a result of a fairly homogenous sample, as reflected in the limited demographic variation among the respondents. Future studies could examine this issue in more comprehensive samples of bicyclists.

As noted, previous research has also found bicycle use (i.e. recreational or commuting) (Kakefuda, Stallones & Gibbs 2009) to be associated with bicycle safety behaviour and -attitudes. Unfortunately, we did not examine whether, or to what extent respondents' bicycle safety behaviours were dependent on the purpose of their trips. This issue should be examined in future research.

We found that bicycle frequency in the winter were associated with bicycle safety behaviour, indicating that winter bicyclists perhaps learn to bicycle safer, as they are exposed to a more challenging environment. We have not seen other research on this.

5.2 Did respondents' TSC influence their bicycle accident risk?

Seventh, we found that respondents' bicycle accident risk was predicted by their bicycle safety behaviours. In spite of its fairly low internal consistency, the bicycle safety behaviour index predicted respondents' bicycle safety accidents risk. We expected this result based on previous research (Bjørnskau 2001, 2005). This result signifies the utility of the traffic safety behaviour measures used in this study.

Eight, respondents' bicycle accident risk was not predicted by their bicycle safety attitudes. It is important to note that although we define TSC as shared traffic safety behaviours and attitudes, bicycle safety attitudes did not significantly predict respondents' bicycle accident risk. Does this mean that our specification of TSC was inappropriate? The fact that we found bicycle safety attitudes to be the strongest predictor of bicycle safety behaviour does not seem to indicate this. However, the finding that negative traffic safety attitudes were not associated with accident involvement seems contrary to results reported by Rakauskas et al (2009). But these authors seem to assume that risky attitudes motivate risky behaviour among rural drivers, increasing their accident risk. It is likely that a potential association between bicycle safety attitudes and bicycle accident involvement is mediated through bicycle safety behaviour. Few studies of safety culture actually focus on the relationship between safety cultures and safety outcomes, and the studies that do focus on this relationship conclude that it is complex, difficult to measure and often indirect (Bjørnskau & Nævestad 2013). As the measures of bicycle safety behaviours and bicycle safety attitudes used in this study seem to be closely related, we may assume that they could be used as specifications of TSC. Further research is, however, needed to shed light on the role of traffic attitudes as a component of traffic safety culture.

It may be relevant to ask whether the conceptual framework of TSC adds value to the bicycle safety behaviour measures used in this study, as they were already known to influence accident risk. However, as reported, certain traffic safety behaviours may be motivated by certain traffic safety attitudes (e.g Rakauskas et al 2009). This is also related to identity (Nævestad 2010; Ward et al 2010), which we unfortunately have not studied. More knowledge on the mechanisms underlying the creation and recreation of TSC could enable us to positively influence traffic safety behaviours and attitudes of road users at risk.

5.3 Limitations of the study

We have measured respondents' perceptions of peers' bicycle safety behaviours and -attitudes, and not their actual behaviours and attitudes. Although we define TSC as bicycle safety behaviours and –atttitudes that are shared in peer groups (cf. Nævestad & Bjørnskau 2012), it is important to note that we only measure respondents' perceptions of what their peers do and not their peers' actual behaviours and attitudes. Thus, though we assume that TSC is shared within groups, we have not managed to actually measure whether it is shared in groups with our study design. It is challenging to assess the extent to which respondents are influenced by their peers, or whether they choose peers who are similar to themselves with respect to background variables, behaviours and attitudes. This is, however a challenge in all culture research, and it is likely that both mechanisms are in play. Although more research is needed, the study indicates that it is fruitful to apply the TSC perspective to the social unit of peer-groups, as Nævestad & Bjørnskau (2012) suggest.

Bicycle safety behaviours and -attitudes could also be associated through the cognitive dissonance mechanism. Cognitive dissonance refers to the discomfort of holding two or more conflicting cognitions. If respondents first are asked whether it is responsible to wear a helmet, and then are asked if they do, it may be more difficult for them to admit that they do not, if they labeled it as responsible. Likewise, respondents' answers on the bicycle safety attitude questions could be influenced by their previously reported bicycle safety behaviours (e.g. they may be less likely to answer that they find behaviours dangerous or irresponsible, if they recently have answered that they regularly engage in these behaviours). In our study, respondents were first asked about their bicycle safety behaviours, and then they were asked other questions before they were asked about their bicycle safety attitudes. Thus, their attitude reports could be influenced by their behaviour reports. It is difficult to rule out both the mentioned cognitive dissonance examples when we collect reports on both behaviours and attitudes.

Can respondents' perceptions of peers' bicycle safety behaviours and attitudes be distinguished from false consensus effects? The false consensus effect comes about when people think that other people do as they do, to justify their own behaviour. It is possible that respondents' assessments of peers' behaviour could be influenced by this effect in a way that made us overestimate their peers' influence in this study.

Table 10 shows bivariate Pearsons r correlations between respondents' own bicycle safety behaviour and the bicycle safety behaviour of different groups. The shares of respondents answering "do not know", when they are asked about helmet use and bicycling under the influence of alcohol, are given in each case. This was done to indicate which groups respondents seem to know the most and the least about.

Table 10: Pearsons r correlations between respondents' traffic safety behaviour and their assessment of the traffic safety behaviour of different groups

Variables:	Helmet use:		Bicycling under the influence of alcohol:	
Groups:	**Correlation:**	**Do not know**	**Correlation:**	**Do not know:**
1) closest female friends:	,427**	10 %	,513**	17 %
2) closest male friends	,461**	8,7 %	,607**	17 %
3) colleagues	,410**	10,8 %	,514**	18,2 %
4) parents	,303**	22,4 %	,329**	19,8 %
5) people in Norway	,355**	11,4 %	,446**	17,8 %

* p < 0,1 ** p < 0,05 *** p < 0,01

The correlations shown in table 10 are are all significant at the 0,05 level. We see that the strongest correlations exist between respondents' traffic safety behaviour and their perception of the traffic safety behaviours of their closest male/female friends and colleagues. These correlations are of medium and large strength. This result could be expected from a peer group approach, presupposing that people are influenced by their peers. However, results also show medium correlations between respondents' bicycle safety behaviour and their perception of the bicycle safety behaviour of people in Norway. This result could not be expected from a peer group approach.

As noted, "People in Norway" was included to examine false consensus effects, and the correlation between respondents' bicycle safety behaviours and the bicycle safety behaviour of people in Norway seems to indicate a false consensus mechanism. All of the respondents cannot be right about the bicycle safety behaviour of people in Norway at the same time. However, this effect could also be explained by simple processes of induction; people might form their ideas about “normal” behaviour on the basis of the behaviour of the people they most frequently observe, i.e. their peers.

But we cannot rule out the possibility that respondents’ perceptions of the other groups to some extent also are influenced by false consensus effects. However, the varying shares of “do not know” for the different groups and questions, and the high “do not know” share for parents seem to suggest that respondents made fairly knowledgeable and sincere assessments of their peers’ behaviour and attitudes.

If we look at the “do not know” shares, we see that respondents’ knew less about their own parents helmet use (do not know: 22,4 %) than they did about people in Norway (do not know: 11,4 %). This result is surprising. Thus, the correlation between respondents’ TSC and the TSC that they ascribe to “people in Norway” should perhaps be interpreted with caution. It seems likely that respondents interpreted this question as an invitation to make a mere guess, and that the guess was influenced by the false consensus effect. Finally, we should not rule out the possibility that respondents made incorrect estimates of their peers behaviour or attitudes, for other reasons, e.g. incorrect memory.

Future research could attempt to distinguish peer influence from false consensus effects through focused surveys that compare respondents’ perception of their peers’ TSC with their peers’ answers. A snow ball recruiting method could be used to achieve this, by using certain respondents as “key” respondents, asking them to send a web survey invitation to their closest friends.

The study is based on self-reports of risk behaviours. As noted above, respondents may be susceptible to the cognitive dissonance mechanism and false consensus effects, they may overestimate the frequency of positive behaviours and underestimate the frequency of negative behaviours. Such tendencies represent limitations of studies based on self-reports, like the present study.

Is the sample representative? The study includes 231 respondents, but as we do not know the actual share of bicyclists among the 1600 people who were introduced to the survey, we do not know the actual response rate of our study. However, based on what we know about the cyclist population in Oslo, Norway from other sources, we conclude that our sample with, a majority of men and people with higher education, seems to be quite representative for the cyclist population in Oslo. This is supported by data from both the Norwegian National Travel Surveys and a recent study conducted in Norway with a sample of more than 4000 cyclist (Fyhri, Bjørnskau & Sørensen, 2012).

Among the Oslo cyclists (N=1053) in the latter survey the average age was 45 years, 62 % were males and 67 % held a major university degree. Our sample consists of 61 % males, the average age is 43 years, and 83 % held a major university degree. The fact that the respondents were recruited among the employees at the science park in Oslo may account for the high proportion of respondents with a university degree. But as noted, cyclists in Norway tend to be better educated than average. Accident and injury frequencies reported by Fyhri, Bjørnskau and Sørensen (2012) were also comparable to what was reported in our study (cf. table 6), and also comparable to those found in an earlier bicycle study (Bjørnskau 2005).

5.4 Implications for traffic safety interventions

Social norms approach. The present study could give rise to a social norms approach to interventions (Berkowitz 2005), as this approach is based on the descriptive norms mechanism. As noted, the underlying idea behind this approach is to remove false consensus effects supporting risky behaviour by informing risk groups about the actual prevalence of risky behaviour of their peers. This approach has successfully been employed in traffic safety interventions (NHtraffic safety attitude 2008; Linkenbach & Perkins 2005). The previously mentioned studies of the relationships between descriptive norms and bicycle safety behaviour also conclude in favour of focusing on descriptive norms in traffic safety interventions (Kakefuda; Stallones & Gibbs 2009; Lajunen & Räsänen 2001, 2004; O'Callaghan & Nausbaum 2006). However, what if road users at risk have fairly correct perceptions of their peers' (un)safe behaviour? This could be the case in high risk subcultures, which may be based on, and defined by risky behaviours. In such cases, it seems that the descriptive norms mechanism cannot be used. This issue should be examined in future research.

Future research could also focus on identity, which is an important component of safety culture (Antonsen 2009). We have not focused on this in the present study. A further development of the traffic safety culture of bicyclists perspective could also focus on other road users interacting with bicyclists, conflicts, and how these road users view each other.

Finally, although the present study suggests that TSC related to bicycling may be related to peer groups, it is important to note that TSC also is shaped by other cultural influences, for example national or regional culture (e.g. Rakauskas et al 2009; Ward et al 2010; Nævestad & Bjørnskau 2012). Although the use of bicycle as a means of basic transportation is higher in for instance the Netherlands than in Norway, few Dutch bicyclists use helmets. This suggests that bicycle safety behaviours and attitudes also are shaped by national culture, and this should be noted in future research.

6. References

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