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Exploring the mechanisms behind the Safety in Numbers Effect: A behavioural analysis of interactions between cyclists and car drivers in Norway and Denmark

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ABSTRACT

In this study underlying mechanisms of the Safety in Numbers (SIN) effect in cyclists were studied. The SIN effect implies that with a higher number of cyclists (as well as pedestrians), their relative injury risks becomes lower. Conflicts between cyclists and cars as well as violations (running through red) were observed in two countries: Norway and Denmark. In Norway, the cyclist share is considerably lower than in Denmark. By comparing two intersections in countries in which the cyclist-share significantly differ, as well as having a more or less comparable infrastructure, it was possible to explore the 'long-term SIN effect' Interactions between car drivers and cyclists. The finding that the proportion of conflicts observed in Denmark is lower than the proportion of conflicts observed in Norway, independent of the season, suggests a long-term SIN effect. That is, cyclists and car-drivers have developed safer interaction-patterns. In Norway the number of cyclist dramatically increase during summer. By studying the same location during spring (April: lower cyclist share) and summer (June: higher cyclist share), short-term SIN effects could be studied. No significance differences appeared in Norway between April and June. These findings suggest that there is no short term change in car drivers expectancies of meeting a bicyclist with increasing numbers of bicyclists. However, these findings should be interpreted with some caution. For now we only have conflict data for one intersection in each country. In order to verify this, more data are needed from several intersections. The observed share of cyclists going through red was in general higher at the Norwegian intersection than at the Danish intersection. This different behaviour of Norwegian cyclists either suggests that these individuals are different (in 'mentality') than Danish cyclists, or that their lower presence and fewer cycling facilities 'forces' them to be in general somewhat more 'daring'.

Keywords: Safety in Numbers, Cycling Safety, traffic conflict analysis, DOCTOR

1 INTRODUCTION

Cycling and walking are largely promoted in recent decennia, coming from an increasing concern about the environmental pollution, for a large part due to non-sustainable transport modes. Another interest to increase the share of cycling and walking is the fact that people are not sufficiently engaged in physical activity, one of the most important factors in staying healthy. An argument against this encouragement of cycling and walking is the greater risk of injury accidents as compared to other modes of transport. However, a number of studies indicate that the risk of injury to cyclists and pedestrians is highly non-linear. This implies, everything else being equal, that the higher the number of cyclists and pedestrians, the lower their injury risk. On the other hand, the more motorized vehicles there are, the higher the risk each cyclist and pedestrian faces. This means that the more car drivers switch to walking or cycling, the safer it gets for pedestrians and cyclists, which argues in favour of promoting these types of transport [1]. The non-linearity of risk injury to cyclists and pedestrians referred to as the Safety in Numbers effect has been fairly recently introduced in transport research literature [1,2] Despite the fact that the SIN effect is a now widely accepted phenomenon and is supported by data on traffic exposure and accident numbers, the underlying mechanism, the causes of this phenomenon, are largely unknown. However, only if we really understand the mechanisms behind the SIN effect, can traffic engineers and policy makers start introducing the most profitable measures to improve safety and promote cycling. The main aim of the present study is therefore to gain more insight in the mechanisms behind the SIN effect for cyclists. This study is part of a larger research project: *Safety in Numbers, uncovering the mechanisms of interplay in urban transport*. This project is financed by the Research Council of Norway.

1.1 Mechanisms in Safety in Numbers

The mechanisms behind SIN most frequently proposed is that with higher numbers of vulnerable road users (VRUs) car drivers become more aware of the possible presence of VRUs and are therefore more attentive. This explanation implies that SIN involves a rather direct short-term effect related to an increasing number of cyclists. This explanation was supported in a preceding study [3]. Related to this mechanism is the explanation that drivers being also a cyclist will consider cyclists when driving, as was recently supported in a survey study [4]. The more people start to cycle, the more drivers will be also a cyclist, which brings about greater cycling safety due to a more positive attitude towards cyclists [5]. A more long-term effect is assumed to be an improved interaction between different road users, based on extensive experience with each other. These processes do obviously require time and do not instantly come into effect with increasing numbers of cyclists. Another proposed mechanism is that VRUs (especially cyclists) who are part of the 'pioneer-group', are more risk-taking than people who decide to cycle when it has become a more common (and accepted) way of transport. A final suggestion is that safer environmental conditions, concerning infrastructure and legislation for VRUs, go together with an increase of VRU numbers, which results in increased safety for individual pedestrians or cyclists [6]. However, this hypothesis needs still to be tested [6].

1.2 Research aim and hypotheses

The aim of the present study was to further explore the SIN effect as well as gaining more insight in the underlying mechanisms of the SIN effect, by a better controlling for possible confounding factors than has been possible in previous studies. Long-term interplay as well as short-term increased experience were the main mechanisms investigated. Interactions between car drivers and VRUs were studied based on camera observations at two intersections; one in Aalborg (Denmark) and one in Oslo (Norway). A major difference between the two countries is the modal share of different road-user groups. In Norway, the modal share of cyclists is 4% [7] , compared to 17% in Denmark.[8] The accident risk for cyclists is considerably higher in Norway [9] than in Denmark [10] (see Table 1). The two countries are also characterized in general by different infrastructural measures, road design and legislation concerning pedestrians and cyclists. Nevertheless, the two specific locations that were studied in Aalborg and Oslo are comparable concerning infrastructural design; despite differences in traffic rules (see 2.2). In both locations, traffic conflicts as well as violations of cyclists and motorized traffic were investigated, based on camera recordings (see 2.3).

By comparing two intersections in countries in which the cyclist-share significantly differ, as well as having a more or less comparable infrastructure, it was possible to explore the 'long-term SIN effect'. It was hypothesized that in Aalborg relatively fewer conflicts would take place between cyclists and motorized traffic, assuming a better interaction based on a long-term interaction experience between cyclists and car-drivers. Moreover, violations (cycling on red) were studied and compared between the two locations, to see whether cyclist risk-taking behaviour (cycling culture) was different for both locations.

Besides studying differences between the two intersections in Aalborg and Oslo, the intersection in Oslo was observed at two different points in time: in April and June. The aim of these measurements at different points in time was to explore a possible short-term mechanism in SIN. Since the seasonal variation in cycling is substantial in Oslo, i.e. a dramatic increase of cyclists during the spring, it was possible to investigate whether a short-term SIN effect takes place in Oslo. This would imply a reduction in the proportion of conflicts observed between cyclist and motorized traffic from April to June, due to the increased number of cyclists and hence a higher attention towards cyclists among car drivers.

Table 1 Number of killed and injured cyclists per person km (million) in Norway and Denmark in 2010.

	Person km (million)	Killed (police records)	Injured (police records)	Risk
Norway 2010	821	7	505	0.62
Denmark 2010	2470	26	688	0.30

2 METHOD

2.1 Selection of locations

The intersections in Denmark and Norway were selected in order to be comparable in terms of layout and traffic volume. . Nevertheless, the volume of motorized traffic at the Norwegian intersection turned out to be considerable higher than at the Danish intersection (see Table 1).

Considering this difference in traffic volumes, it is crucial to consider the number of encounters in general between cyclists and car drivers when comparing the number of conflicts (see 2.4.2). The number of cyclists is comparable for the Norwegian intersection in June and the Danish intersection in September, as expected. The number of cyclists at the Norwegian intersection in April was (as expected) considerably lower. The general layout of the two intersections is comparable and both are signalized. The two most important differences are (i) that there is no cycle path present on the minor road at the Norwegian intersection and (ii) that there is a separate signal phase for left-turning traffic on the main road at the Norwegian intersection. This implies less interaction between straight-on going traffic on the main road and left turning traffic from the other direction.

Table 2 Number of motor vehicles and cyclists at the Norwegian and Danish intersection. Numbers are counted for all arms of the intersection, , for 1 day from 6.00 hrs. – 21.00 hr. T traffic numbers are counted for 5 minutes intervals and extrapolated to whole hours.

	Norway – April 2013	Norway – June 2013	Denmark – Sept 2013
No of cyclists (6.00-21.00)	930	2.940	3.474
No of motor vehicles (6.00-21.00)	19.620	26.521	17.052

2.2 Description of locations

Before going into the specific characteristics of each studied intersection, first the international differences concerning traffic rules are briefly discussed below.

Norway

When cycling on the road, cyclists have the same rights and obligations as the motorized traffic, including giving way to traffic from the right, to pedestrians on zebra crossings etc. When cyclists are cycling on a pedestrian/cycle path that crosses a road, a cyclist must give way to all other motorized traffic (except on exits). Cyclists are allowed to cycle on the sidewalk or to mingle with motorized traffic, for example turning left or right within the same lane as motorized traffic. Cyclists that come from the pavement and want to enter or cross the driving lane, must give way to other road users. Cars making a right turn are no longer obligated to give way to cyclists coming from the pavement (after 1998). In Norway cyclists are allowed to cycle on zebra-crossings, but if they do they have to give priority to other traffic, while other traffic has to give priority to pedestrians. However, in practice car drivers give priority to cyclists on zebra crossings [17]. Mopeds are not allowed on the cycle path and right turning on red is not allowed.

Denmark

In Denmark cyclists are obliged to use the cycle path if available. In Denmark cyclists are not allowed to cycle on sidewalks, nor on zebra-crossings. In case they do use them to cross, they should step off their bike, i.e. use it as a pedestrian. They are allowed to mingle with right turning motorized traffic, but not with left-turning traffic. Here the cyclist must make a big left turn – which means to continue to the far corner of the intersection and wait here for green traffic light in the transverse direction (this is a so called 'banana-turn). Mopeds (30 km – not 45 km) are allowed on the cycle path and right turning on red is not allowed.

Danish intersection: Aalborg, Kong Christians Allé – Hasserisvej.
This is a signalized four-arm intersection between the Kong Christians allé (arm 1 and 3, see

Figure 1) and the Hasserisvej (arm 2 and 4, see

Figure 1) in Aalborg. The Kong Christian allé is a busy two-way main road running around the centre of Aalborg (ring road) with a speed limit of 50 km/h. It has priority on the Hasserisvej (in case the signals do not work). Hasserisvej is a minor road with a speed limit of 50 km/h, leading towards and outwards the city centre of Aalborg. The Kong Christian allé has in both directions one lane to turn left and one shared lane for traffic going straight ahead and turning right. It has a bicycle track on both sides of the roads. A heightened cycle track starts at ca. 30 meters at both sides from the crossing (separated by a curb from the main road), but changes into a simple cycle lane close to the intersection (only separated from the main road by a continuous white line. This is the same for the bicycle track at the Hasserisvej. The Hasserisvej is a two-way road, with a single lane for all directions at the intersection. All 4 arms of the intersection have a zebra crossing (signalized).

Both directions of motorized and cycle traffic on The Kong Christian have green light at the same time (arm 1 and 3) after which both directions for motorized and cycle traffic on the Hasserisvej have green light (arm 2 and 4). Parallel zebra crossings have green at the same time (see Figure 2). Traffic lights are time controlled, i.e. based on a fixed time schedule.

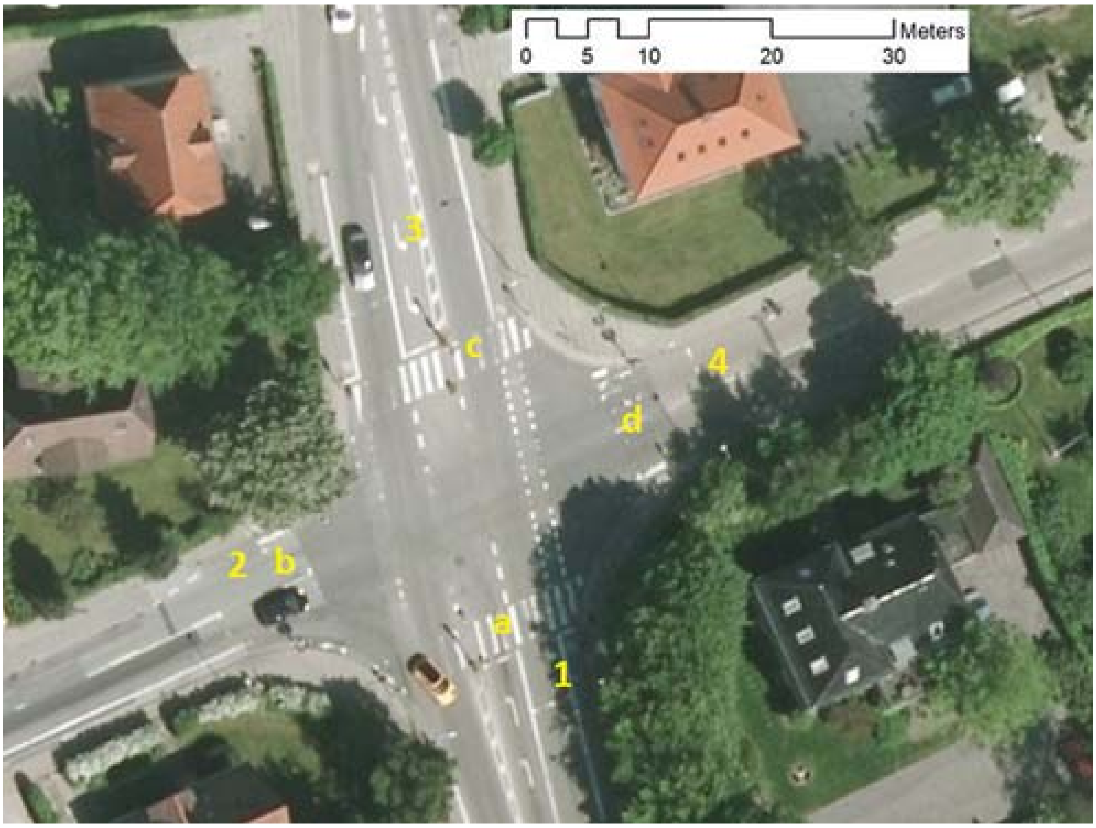

Figure 1 Intersection Aalborg, Denmark: Kong Christian allé (1-3) – Hasserisvey (2-4)

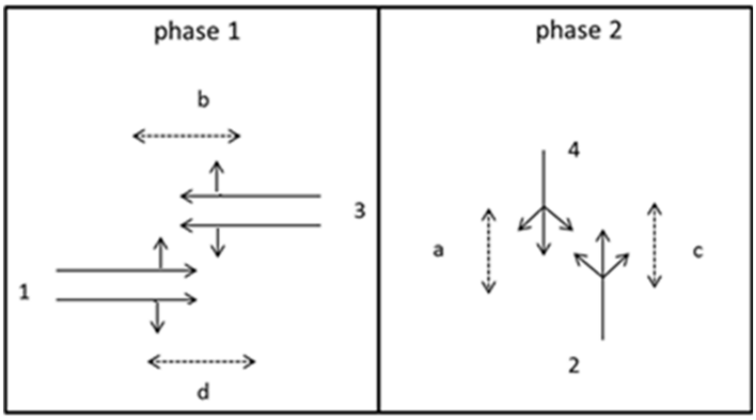

Figure 2 Signalization scheme intersection Aalborg

Norwegian intersection: Oslo, Suhms Gate – Kirkeveien.
This is a signalized four-arm intersection between Kirkeveien (see, arm 3 and 4) in Oslo. The Kirkeveien is a busy two-way main road running around the centre of Oslo (ring road 2), with a speed limit of 50 km/hr. It has priority ton Suhms gate, in case signals are not functioning. Suhms gate is a minor road with a speed limit of 40 km/hr on arm 4 and a speed limit of 30 km/hr on arm 2. It leads to either the city centre of Oslo or the University area, outside the city centre. The Kirkeveien has in both directions three separate lanes: for left turning, straight ahead and straight ahead and right turning combined. It has a bicycle track at both sides of the road in both directions, separated from the traffic by a dotted white line. Suhms gate does not have a bicycle lane. Suhms gate is a two-way road with only one driving lane in each direction. All 4 arms of the intersection have zebra crossings (signalized). The directions for motorized traffic and cyclists in straight direction and right turn have green at the same time on Kirkeveien (arm 1 and 3). The zebra crossings at the arms 2 and 4 have green at the same time. This is followed by the green phase for both directions at Suhms gate (arm 2 and 4), as well as zebra crossings at arms 1 and 3. In the final phase of the signal cyclus, left turn directions at Kirkeveien get green (see Figure 4). Traffic lights are time controlled, i.e. based on a fixed time schedule.

Figure 3 Intersection Olso, Norway: Kirkeveien (1-3) – Suhms Gate (2-4)

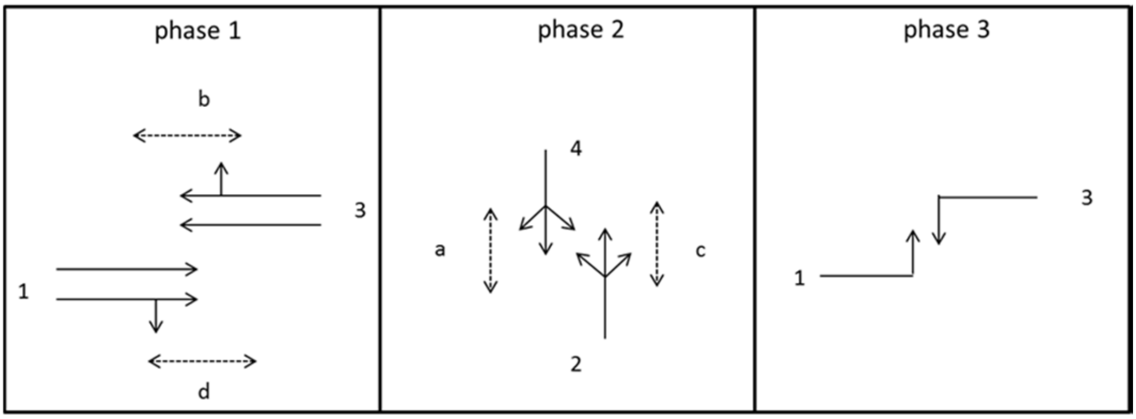

Figure 4 Signalization scheme intersection Olso

2.3 Video recordings

Behavioural and conflict analyses were conducted based on video observations. At each intersection, a camera covered with a weather-protected box was mounted to a building or a post in order to have a good overview of the intersection. The video was recorded with relatively low resolution (640x480 pixels), which did not allow for recognising individual persons or number plates on cars. It was however sufficient to see and interpret road user behaviour and interaction. The video was split in 30-minutes intervals and stored on a mini-computer connected to the camera. The data were recorded for 1.5-3 weeks, but eventually 5 workdays were analysed from 6.00-21.00 for the Norwegian intersection in April and the Danish intersection. Due to technical issues, these 5 workdays were distributed over 7 workdays for the Norwegian intersection in April. The days were selected to represent the normal traffic conditions for the selected season, not affected by public holidays or extreme weather conditions. See Table 3 for the dates for which data have been analysed, for each intersection.

Table 3 Overview of the days for which data were analysed for each intersection.

Intersection	**April 2014**	**June 2013**	**Sept 2013**
Norway	11, 14-16, 23-25	6-7, 10-12	
Denmark			23 – 27

2.4 Analysis

Video-recordings were analysed using the program T-Analyst [10] developed at Lund University. The program was specifically designed to analyse road user interaction based on video data. T-Analyst efficiently manages a large number of detected events in long video recordings, allows to label them and afterwards filter them based on the labelling. Moreover, trajectories of road-users can be extracted, based on which specific parameters related to interaction between road-users are calculated (see 2.4.1). First, a pre-screening of the footage by students took place, in which every possible violation and conflict was registered. The students' instructions were to mark any "unusual" situation such as strange route, congestion, "narrow coming", powerful braking, etc. Afterwards the selected events were reviewed, analysed and categorized by a person trained in conflict analysis.

2.4.1 Conflicts

In order to gain insight into differences in safety between the two intersections, traffic behaviour was analysed according to the Dutch Objective Conflict Technique for Operation and Research (DOCTOR) [12]. Since traffic accidents are very rare events, safety critical behaviour was studied to gain more insight in the causes of safety problems. The processes that result in near-accidents have much in common with the processes preceding actual collisions [13]. The frequency of the occurrence of traffic conflicts is much higher compared to accidents. Moreover, they offer a rich source on causal relationships, since the preceding process can be systematically observed. The DOCTOR method was developed in the Netherlands by the Institute of Road Safety Research (SWOV) and TNO Human Factors. A DOCTOR manual has been developed in which the method is described in detail [14], and has recently been updated and translated in English [15]. According to the DOCTOR method, a critical situation is defined a situation in which the available space for manoeuvre is less than is needed for normal reaction [14] A conflict between road users is at hand if at least one of the parties involved needs to do something to avoid a collision. In some cases, road users pass each other very narrowly without a noticeable evasive action has taken place. These situations can also be critical since a small disturbance in the approach process could easily have resulted in a collision [14]. The severity of a conflict is scored on a scale from 1 to 5, taking into account: 1. The probability of a collision and 2. The extent of the consequences if a collision had occurred. The parameters Time-To-Collision (TTC) and Post Encroachment Time (PET) determine the probability of a collision. The extent of the consequences are defined by the type of conflict-partners, the speed as well as the type of manoeuvres displayed.

Time-To-Collision (TTC)
TTC is ‘ the time required for two vehicles to collide if they continue at their present speed and on the same path’. The severity of an encounter is indicated by the minimum TTC (TTCmin) that is reached during the approach of two vehicles. The lower the TTCmin, the higher the collision risk will be. A TTCmin of 1.5 sec or less is considered as critical.

Post-Encroachment-Time (PET)
Whereas the TTC can only be used in case of a collision course PET values represent ‘near-misses’. It is defined as the time between the moment that the first road-user leaves the path of the second road-user and the moment that the second road-user reaches the path of the first (see Figure 5). In urban areas PET values lower than 1 sec are considered as possibly critical. In the program used for analysis, PET values could not be analysed. Instead Time Advantage (TA) and Time to Arrival (T2) were calculated. TA may be considered as an extension of PET, since it says at each moment in time what the PET value is expected to be, if road users continue with the same speeds and paths. TA is a predicted PET value, generating several values during one critical interaction, whereas PET has a single value which is measured directly [15]. However, as Laureshyn et al. [16] argue, TA in itself is not a valuable source of information, since it is also important to know how soon the encroachment will occur. Therefore, T2 has been introduced, indicating the time it takes the second road user to arrive at the ‘avoided collision point’. To have a decent indication of the PET values, in case of a ‘near miss’ the TA value was registered at the minimum T2 value.

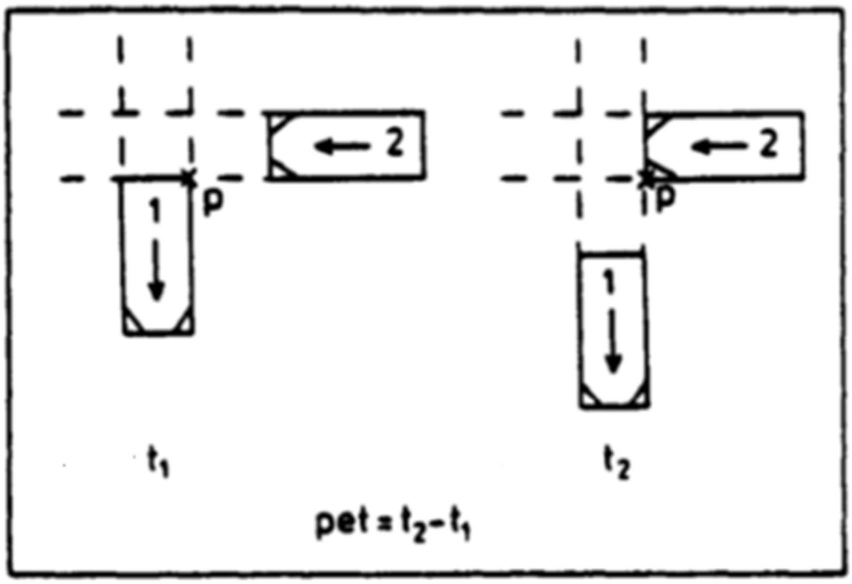

Figure 5 Definition of Post Encroachment Time

2.4.2 Exposure

Conflicts
When comparing locations and periods, in terms of traffic safety / traffic behaviour, considering absolute measures is uninformative. The number of observed conflicts is of course dependent on the number of encounters, i.e. possible conflicts. Based on the number of passing

road-users (traffic flow), several approaches have been proposed to calculate the number of encounters (see for example [17]). If however locations are complex and several traffic flows have to be taken into account, these approaches are not reliable. In such cases the most reliable and robust method is still to count the number of encounters. Since the studied locations here are characterized by complex traffic flows as well as being signalized, counting was considered the only feasible option. Because this is rather time-consuming, encounters were only counted for the most numerous and interesting type of conflict between a cyclist and a car. For both Norway and Denmark, a turning car not yielding to a cyclist going straight, was the most frequently observed conflict. Therefore, the number of times a car turns while a cyclist goes straight was counted (see chapter 3). This was defined as follows:

- The turning car and the cyclists are within the squared area marked by the zebra-crossings.
- If a cyclist is present and the turning car is at the same position within 2 seconds.
- If a car is waiting to turn (first in line) and a cyclist passes.

Counts were executed for the first half hour of each hour for 1 day (a Wednesday), from 6.00 hrs. – 21.00 hrs. Numbers were then extrapolated for each hour and consequently for 5 days.

Violations; running through red

Concerning the number of cyclists going through red light, exposure could simply be expressed as the number of cyclists present during the same period of time at both locations. This was done for 1 day (Wednesday) for all directions (arms), from 6.00 hrs. – 21.00 hrs. Then numbers were extrapolated for 5 days. By considering other days of the week for a small amount of time, it was verified whether counts were very different for different weekdays. This was not found to be the case.

3 RESULTS

3.1 General observations

Besides quantitative analysis of the videos, remarkable general differences road-user behavior between Denmark and Norway have been observed. First of all, Norwegian cyclists seem to be much more risk taking than Danish cyclists. Whereas Danish cyclists follow the ‘normal’ paths to cross the street, many Norwegian cyclists seem to cross wherever and whenever they see an opportunity to do so. Whereas they should give priority to other traffic when cycling on a zebra-crossing, they are always given priority by motorized traffic.

In Denmark many ‘banana-turns’ were observed. When they want to turn left, they first enter the street on their right and then turn to wait for the red light to go straight ahead (which is left considered from their starting position). This prevents cyclists to mingle with motorized traffic when turning left (see also 2.2).

It seems that, in both countries, cyclist are reluctant to mingle with motorized traffic, i.e. to use the car lane when no cyclist lane is present. In both countries it is allowed to do so (at least when turning right), but apparently cyclist do not prefer this option. Cyclists often use zebra crossings to cross the street.

3.2 Conflicts

General

Table 4 provides an overview of the number, type and severity (based on the DOCTOR method) of observed conflicts between cyclists and cars at the Danish and Norwegian intersections. See Appendix A for an overview of all traffic conflicts observed. In

Table 5 the number of light (conflict severity 1-2) and severe (conflict severity 3-5) between cars and cyclists are shown, as well as their share of the total number of passing cyclists. A X^2-test (based on the number of conflicts as a share of the number of cyclists) revealed that there is a significant association between country and the total number of conflicts. For Norway April and Denmark: X^2 (1) = 13.04, p = 0.00. For Norway June and Denmark, X^2(1) = 10.8, p = 0.00. Also for the light conflicts, the share of conflicts was found to be significant higher in Norway than in Denmark. No country effects were found for severe conflicts. Moreover, no association was found between the period of time within Norway and the number of conflicts.

Table 4 Number, type and severity of conflicts at the intersections

		CONFLICTS					
Conflict type		**Car not yielding**	**Cyclist on red**	**Cyclist on zebra**	**Car on red**	**Other**	**Total**
Norway - April 2014		7	3	3	0	2	**15**
Norway - June 2013		24	10	8	1	1	**44**
Denmark - Sept 2013		8	4	3	1	3	**19**
Conflict severity							
Norway - April 2014	**1**	2	0	1	0	0	**3**
	2	1	1	1	0	1	**4**
	3	0	0	0	0	0	**0**
	4	0	0	0	0	0	**0**
	5	0	0	0	0	0	**0**
Norway - June 2013	**1**	5	1	1	0	0	**7**
	2	13	4	3	1	1	**22**
	3	5	5	4	0	0	**14**
	4	1	0	0	0	0	**1**
	5	0	0	0	0	0	**0**
Denmark - Sept 2013	**1**	2	1	1	0	0	**4**
	2	4	1	1	0	1	**7**
	3	2	2	1	1	2	**8**
	4	0	0	0	0	0	**0**
	5	0	0	0	0	0	**0**

Table 5 Number (percentage) of light and severe conflicts between cyclists and cars. Percentage is calculated as the number of conflicts divided by the total number of cyclists on 5 days.

	Light conflicts	Severe conflicts	Total
Norway April	12 (0.3%)	3 (0.1%)	15 (0.3 %)
Norway June	29 (0.2%)	15 (0.1%)	44 (0.3%)
Denmark Sept	11 (0.1%)	8 (0.05%)	19 (0.1%)

Turning car, cyclist going straight

Table 6 shows the number and share of conflicts between a cyclist going straight on and a turning car. Only in case of a left turning car, a significant difference in the share of conflicts between Denmark and Norway June was found (Likelihood ratio (1) = 20.6, p = 0.00).

Table 6 The number of conflicts caused by car drivers not yielding to cyclists as well as the conflict share of the total number of encounters between a turning car and a cyclist going straight on (counted for 5 days, 6.00 – 21.00). Number of encounters were counted for 1 day and extrapolated to 5 days.

	Car left, cyclist straight			Car right, cyclist straight		
	Nr of conflicts	Nr of encounters	Share	Nr of conflicts	Nr of encounters	Share
Norway April	1	465	0.2%	6	505	1.2%
Norway June	11	1300	0.8%	13	1495	0.9%
Denmark Sept	1	3085	0.03%	7	1120	0.6%

3.3 Violations: cycling through red

Table 7 Number of cyclists going through red (% of the total number of passing cyclists)

	Cyclists through red
Norway April	159 (3.4%)
Norway June	1020 (6.9%)
Denmark Sept	486 (2.8%)

Considering the total percentage of cyclist going through red, a significant overall difference was found between countries: X^2 (2) = 330,7, p = 0.00, as well as between April and June in Norway: X^2 (2) = 76,5, p = 0.00.

4 CONCLUSION AND DISCUSSION

The aim of this study was to investigate possible underlying mechanisms of the widely supported Safety in Numbers effect. By observing locations with comparable characteristics, but in general different shares of cyclists as well as a location with changing shares over the year, short term as well as long-term mechanisms involved in the SIN effect could be addressed. In case of long-term effects, differences in cyclist-car interaction are expected to be found between Denmark and Norway in general. In case of short-term effects, differences in time due to increasing cycling shares in Norway are to be expected.

Conflicts

A significant difference was observed between the number of conflicts at the Danish intersection and the Norwegian intersection; the share of cyclists involved in a conflict was higher in Norway (in June), than in Denmark. When all conflicts were divided into light and severe conflicts, this effect was found for the light conflicts but not for the severe conflicts. One possible reason why no significant effects were found for the severe conflicts may be that the observation time was too short to make a valid statement on severe conflicts, since they do not occur frequently.

Both in Norway and Denmark the most frequent types of conflicts observed were the ones in which a turning car does not yield to a cyclist going straight ahead. This is of course in most cases not a consciously made mistake, but due to the car driver not noticing the cyclist. This neglect can be caused by the fact that a car driver looks in the direction cyclist can come from but fails to see the cyclist. Another reason can be that the car driver does not look at all, i.e. forgets about the possibility of a cyclist being present. .

The finding that the proportion of conflicts observed in Denmark is lower than the proportion of conflicts observed in Norway, suggests a long-term SIN effect. That is, cyclists and car-drivers have developed safer interaction patterns. The share of 'turning-conflicts' are however most reliable to consider, since the number of encounters for these type of conflicts are actually counted, as opposed to other type of encounters leading to a possible conflict. The analyses reveal that only for left-turning car is there a significant difference between the share of conflicts observed at the Norwegian intersection in June and the Danish intersection.

No significance differences appeared in Norway between April and June. Given that there is a considerable increase in the number of cyclists on the road from April to June, these findings suggest that there is no short-term change in car drivers expectancies of meeting a bicyclist with increasing numbers of bicyclists. In other words, the suggested SIN mechanism of increased awareness was not found in the data. However, this finding should be interpreted with some caution. For one thing, we only have data for one intersection with rather few observations. In order to do a proper empirical test of this mechanism, we need data from several intersections. Nevertheless, the findings from the present study suggest that the SIN effect is not something that appears overnight, as a mechanistic change in drivers' expectations, but rather as a result of long term interplay and development of traffic culture.

Violations

An important component of cycling culture is the extent to which cyclist violate the traffic rules. Since traffic lights have the same meaning in Denmark and Norway whereas quite some other rules differ, red light violations by cyclists were registered. The observed share of cyclists going through red was in general higher at the Norwegian intersection than at the Danish intersection. This is in line with the more general observations of the behaviour of cyclists in Norway and Denmark: Norwegian cyclists display more assertive, risky behaviour than Danish cyclists. This difference suggests that Norwegian cyclists differ from the Danish in 'mentality', or that their lower presence and fewer cycling facilities 'forces' them to behave somewhat more 'daringly'.

Moreover, cycling through red was found to be more frequent in June than in April at the Norwegian intersection. This suggests that with increasing numbers of cyclists in Norway, the share of 'risk-taking' or unexperienced cyclists increases. This may even counteract and hide a potential SIN effect. In other words, car drivers might become more aware of cyclists throughout the season, but the benefits of this might be cancelled out by the increased level of risky behaviour by bicyclists.

Overall findings indicate a long-term SIN effect. The number of conflicts is lower when the share of cyclists is higher, which hints at a long-term ' interaction mechanism': an improved interplay between different road users, based on extensive experience with each other. A short-term SIN effect is not supported by the current data. This seems to contradict the findings of Fyhri et al. [3]. In this study, Norwegian cyclists reported to experience a fall in failed-to see situations by car drivers from April to June, and a further improvement from June to September. This short-term change is indicative of an increased attention from car drivers, in other words they are more alert towards encountering cyclists when approaching an intersection. Fyhri et al.'s results were however based on interviews. It could be that they observed a change in subjective experience of safety over time, i.e. that cyclists became more confident over the season with more cycling experience. On the other hand, the current findings are based on limited data and locations. Currently more data are being registered and analyzed.

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Appendix A Total overview of traffic conflicts

B = bicyclist, C = Car, P = Pedestrian, M = Moped

Conflicts at Danish intersection – Sept 2013

Conflict type	Car not yielding (or late)	Cyclist on red	Cyclist on zebra	Car on red	Pedestrian on red	Oher	Total
C-B	**8**	**4**	**3**	**1**	**0**	**3**	**19**
C-C	1	1	0	1	0	0	3
C-P	0	0	0	0	0	0	0
C-M	0	0	0	0	0	0	0
B-B	0	1	0	0	0	0	1
B-P	0	0	0	0	0	0	0
Total	**9**	**6**	**3**	**2**	**0**	**3**	**23**
Conflict severity							**Total**
1,0	2	1	1	0	0	0	4
2,0	5	2	1	0	0	1	9
3,0	2	3	1	1	0	2	9
4,0	0	0	0	1	0	0	1
5,0	0	0	0	0	0	0	0

Conflicts at Norwegian intersection – April 2014

Conflict type	Car not yielding (or late)	Cyclist on red	Cyclist on zebra	Car on red	Pedestrian on red	Other	Total
C-B	**7**	**3**	**3**	**0**	**0**	**2**	**15**
C-C	0	0	0	2	0	0	**2**
C-P	0	0	0	0	0	0	0
C-M	0	0	0	0	0	2	**2**
B-B	0	0	0	0	0	0	0
B-P	0	0	0	0	0	0	0
Total	**7**	**3**	**3**	**2**	**0**	**4**	**19**
Conflict severity							**Total**
1	**4**	0	**1**	1	0	1	7
2	**2**	**2**	**1**	0	0	1	6
3	**1**	**3**	**1**	1	0	0	6
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0

Conflicts at Norwegian intersection – June 2013

Conflict type	Car not yielding (or late)	Cyclist on red	Cyclist on zebra	Car on red	Pedestrian on red	Other	Total
C-B	**24**	**10**	**8**	**1**	**0**	**1**	**44**
C-C	2	1	0	4	0	0	7
C-P	2	0	0	0	1	0	3
C-M	0	0	0	1	0	1	2
B-B	0	0	1	0	0	0	1
B-P	0	1	0	0	1	0	2
Total	**28**	**12**	**9**	**6**	**2**	**2**	**59**
Conflict severity							**Total**
1	7	1	1	2	0	1	12
2	13	6	4	4	1	1	29
3	6	5	4	0	0	0	15
4	2	0	0	0	1	0	3
5	0	0	0	0	0	0	0