Institute of Transport Economics
Norwegian Centre for Transport Research

Summary:

Safety in Numbers - uncovering the mechanisms of interplay in urban transport

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When more cyclists turn to the roads in Oslo each spring, the risk for each cyclist of being involved in a conflict or near miss is reduced. In other words there is proof of a Safety in Numbers effect. Comparing Norwegian road users with their Danish and Swedish counterparts shows that this effect can either be accentuated or reduced by differences in infrastructure quality and traffic culture (norms about how to behave to each other).

Bicycle advocates and other stakeholders with an interest in arguing for a shift from motorized to non-motorized travel often rite the concept of "Safety in numbers" (SiN) as an argument against the concern about a potential increase in numbers of accidents resulting from such a policy. The concept of SiN is used to explain the non-linear statistical relationships between the number of pedestrians or bicyclists and the number of injuries for the same group (Elvik, 2009; Geyer, Raford, Ragland, & Pham, 2006; Jacobsen, 2003). The mechanism has been proven in a number of cross sectional and longitudinal studies, summarised in a quite recent meta-analysis (Elvik & Bjørnskau, in press). The concept has been subject to debate, regarding its existence (Bhatia & Wier, 2011), its mathematical characteristics (Brindle, 1994; Elvik, 2013; Knowles et al., 2009) and also related to this, regarding a clear understanding of *the mechanism* behind the safety in numbers effect.

The Scandinavian countries, and in particular Norway are interesting cases to test the SiN effect, as there is a substantial seasonal variation in bicycle use. The seasonal variation is substantial, meaning that every spring there is a dramatic increase in the number of bicycles other road users are exposed to each subsequent week. By studying conflicts and interactions at the same study sites, it is possible to keep a close control with any other potential influencing factors, and only look at the effect of changes in the share of one of the road user groups. In other words, this situation can be used as an experiment of the SiN effect. In the current study, we exploit this variation in cycling levels and infrastructure design in order to give a better explanation of the mechanisms involved in the SiN effect. The same interviews and video recordings that were conducted in Norway were also conducted in Denmark and Sweden.

The current report summarizes a three-year research program carried out at the Institute of Transport Economics (*Safety in Numbers - uncovering the mechanisms of interplay in urban transport*). The project consisted of several work packages, all aiming

to either test the existence of the SiN mechanism or to the unravel mechanisms behind it. The report is structured around 15 different hypotheses regarding SiN. In addition potential contributions from infrastructure and traffic culture in explaining the SiN phenomenon are discussed.

Specifically we hypothesize that from April to June and from June to September, there is a reduction in number of …

1. … times bicyclists are not seen by car drivers
2. … times bicyclists are not seen by pedestrians
3. … times car drivers are surprised by a bicyclist
4. … times pedestrians are surprised by a bicyclist
5. … times cyclists are involved in near-misses with car drivers
6. … times cyclists are involved in near-misses with pedestrians
7. … traffic conflicts between car drivers and bicyclists[1]

Regarding the cross national differences we expect that Norwegian …

8. … bicyclists are more often overlooked by cars …
9. … bicyclists are more often overlooked by pedestrians …
10. … bicyclists are more involved in near-misses with car drivers
11. … bicyclists are more involved in near-misses with pedestrians …
12. … car drivers are more often surprised by a bicyclist …
13. … pedestrians are more often surprised by a bicyclist …
14. … bicyclists are more often involved in traffic conflicts with car drivers[1]…

…than their Danish and Swedish counterparts.

In addition, we have conducted a separate survey of tram drivers, who are interviewed at three different time points. For these data we have the following hypothesis:

15. The number of times tram drivers are surprised by bicyclists is reduced, from April to June and from June to September

The data collection procedure was quite complex and extensive and provided several sources of information for answering the hypotheses:

- Survey data with car drivers, cyclists and pedestrians from April, June and September collected in the field, in order to study the seasonal effects
- Survey data with car drivers, cyclists and pedestrians from April, June and September collected in a home survey, in order to study the seasonal effects and get more background information
- Video data from four intersections in Oslo from April, June and September collected in the field, in order to study conflicts between cyclists and cars

[1] As measured by video observations

- Video and survey data (like above) from Aalborg (Denmark) and Gothenburg (Sweden) in order to capture longer term effects of differences in cycling levels, and differences in traffic culture and infrastructure
- A survey of tram drivers from April, June and September collected in the field, in order to study the seasonal effects

We have summarised the results of the analyses in one table for the seasonal data and one for the cross national comparisons below.

Table S1 Summary of hypotheses 1-7 and 12 (seasonal effects). The arrows indicate increase, decrease or no change between different periods. Green colour indicates confirmation of hypothesis, yellow indicates that it is not confirmed and red indicates that change is opposite of what is hypothesised.

		April to June	June to September
H1	Cyclists overlooks by cars	↘	↘
H2	Cyclists overlooks by pedestrians	→	↘
H3	Car drivers surprise by cyclists	→	→
H4	Pedestrians' surprise by cyclists	→	→
H5	Cyclists near-misses with cars	↘	→
H6	Cyclists near misses with pedestrians	↘	↗
H7	Conflicts with cars (video)	→	↘
H15	Tram drivers' surprise by cyclists	↘	→

Regarding seasonal variation, only the first hypothesis is fully confirmed, in the sense that overlooks drops both from April to June and from June to September. H2, H5, H6 and H7 are all partly confirmed since overlooks and near misses drops at one point in the season. H3 and H4, regarding other road users' surprises are not confirmed. However, H15 regarding tram drivers' surprises is partly confirmed.

The results suggest that bicyclists experience a short term Safety in Numbers effect through the season. Each individual cyclist experiences fewer occasions of being overlooked by cars and fewer safety critical situations (near-misses). Video observation data confirm this pattern. However, the SiN effect seems to be countered by another mechanism taking place at the same time: The influx of inexperienced and risk-taking cyclists through the season. Thus car drivers and pedestrians also report to find themselves being surprised by cyclists in traffic late in the season.

As a separate task, accident data were collected from a prospective population-based study, during 2014 at the Oslo Emergency Clinic. The analysis of cycle flow and accident data can be used to illustrate the SiN effect. We found that both collisions and single accidents are closely related to the number of cyclists on the road. However, when we look at the relative difference between single accidents and collisions (the ratio), we see that collisions decrease relative to single accidents when cyclist numbers increase. In December 28 percent of all cyclist accidents are collisions, a figure that drops to 10 percent in July.

The table below summarizes the cross national comparisons in the report, as gold, silver and bronze medals.

Table S2 Summary of hypotheses 8-11. Ranks from 1st (gold) via 2nd (silver) to 3rd (bronze) place.

		Denmark	Sweden	Norway
H8	Overlooks by cars			
H9	Overlooks by pedestrians			
H10	Near miss with car			
H11	Near miss with pedestrian			
H12	Car drivers' surprise by cyclists			
H13	Pedestrians' surprise by cyclists			
H14	Conflicts between cars and cyclists			

Our hypotheses regarding cross national differences are partly confirmed. For all of the hypotheses, except number 10 (near misses with cars), Denmark (Aalborg) comes out as the sole winner. This was as expected. When comparing Sweden (Gothenburg) and Norway (Oslo), the results are mixed. Depending on the data, we find that interplay between cyclists and other roads users sometimes is worse, sometimes the same, and some times better in Norway. Hence there seems to be certain difference in how cyclists interact with other road users, that has evolved over time, a long term SiN effect.

One explanation for the not-expected poor level of interplay in Sweden compared to Norway, is the particular infrastructure design used in many central pars of Gothenburg, where there are designated marked cycle paths either on pavements, or in the central part of bidirectional boulevards, where also pedestrian are supposed to walk.

Our discussions regarding the role infrastructure and traffic plays in explaining this long term effect is a bit inconclusive. We see that infrastructure does play a role, the badly designed Danish solutions (such as marked cycle paths in roundabouts) give *more* conflicts than the average Norwegian. Also, the Swedish solution mentioned above, seems to be conflict inducing. But, including infrastructure as a variable in multivariate models does not explain away national differences, which can be seen as indicative of a SiN effect regardless of different infrastructure quality. Further we find that road users are far more rule obedient and considerate in Denmark than in Sweden and Norway. But again, including a measure of traffic culture into the multivariate models does not explain any differences in near misses or surprises.