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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.

ICSC, 19 November 2014, Göteborg

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Safety in Numbers (SIN)

- With an increasing number of cyclists safety for each individual cyclist increases
- Well known phenomenon
- Understanding underlying mechanisms is important in order to design effective measures.

Proposed mechanisms

1. Car drivers become *more attentive* (short term)
2. *The quality of interplay* improves (long-term)
3. *Population* effect; «innovators» act risky
4. Better *infrastructure*


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Aim

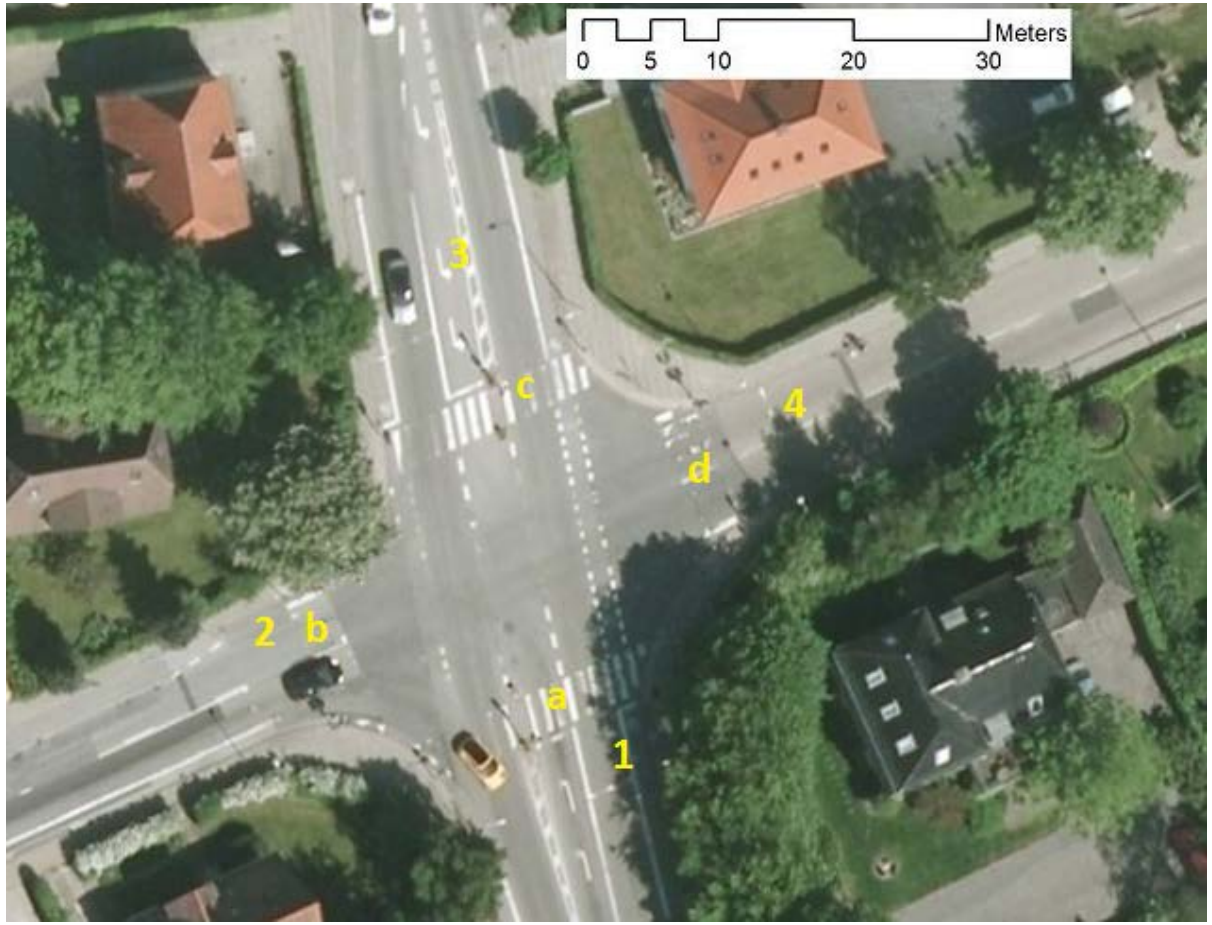
- Gaining more insight in the underlying mechanisms based on behavioural observations
- Studying long-term as well as short-term SIN effects
  - Long-term: a better interplay between cyclists and car drivers
  - Short-term : more attention towards cyclists.
- Cycling culture: difference in violations

Long-term mechanisms

Short-term mechanisms

Locations

Oslo: *Kirkeveien (1-3) – Suhms Gate (2-4)*



Aalborg: *Kong Christian allé (1-3) – Hasserisvey (2-4)*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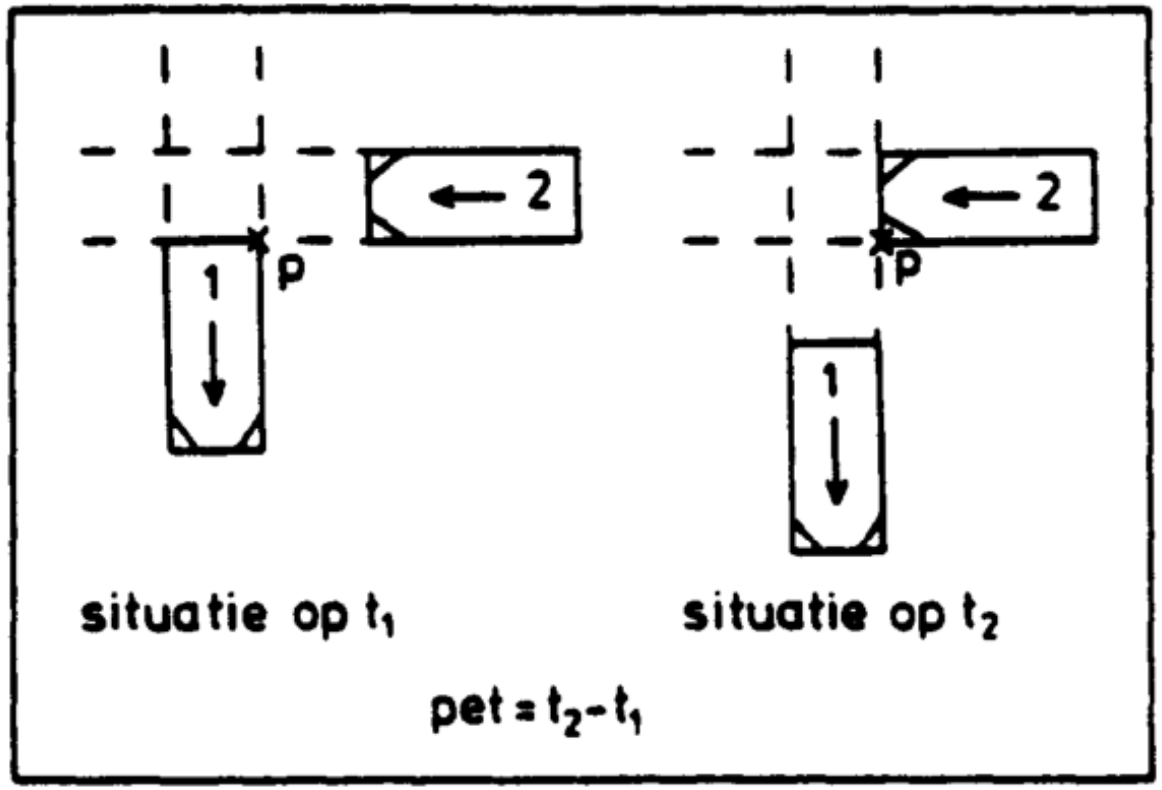
Analyses

- Norway April 2014: 5 days, Monday-Friday, 06.00-21.00
- Norway June 2013: 5 days, Monday-Friday, 06.00-21.00
- Denmark Sept 2013: 5 days, Monday-Friday, 06.00-21.00


Conflicts: DOCTOR

- Dutch Objective Conflict Technique for Operation and Research
- A critical situation is defined as a situation in which the available space for manoeuvre is less than is needed for normal reaction (Van der Horst & Kraay, 1986)
- Conflict severity is determined by:
  - *Time To Collision / Post Encroachment Time*
  - *Potential consequences (vulnerability, speed)*
- Severity levels: 1 (light) – 5 (very serious)

Post Encroachment Time




General observations

- In Norway cyclists seem more risk-taking.
- ‘Banana turns’ in Denmark
- In Norway cyclists often use the zebra, not yielding to the cars.



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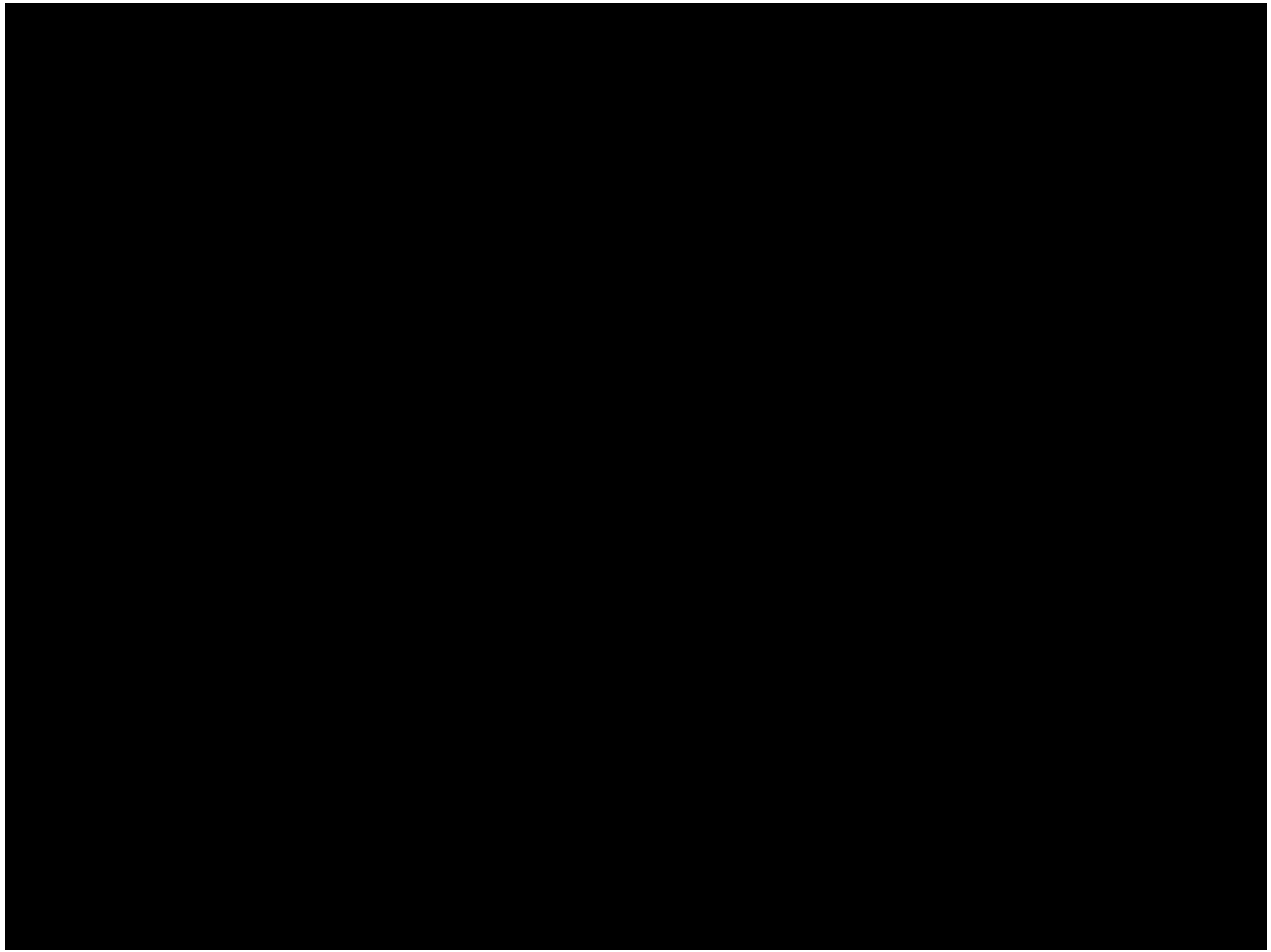


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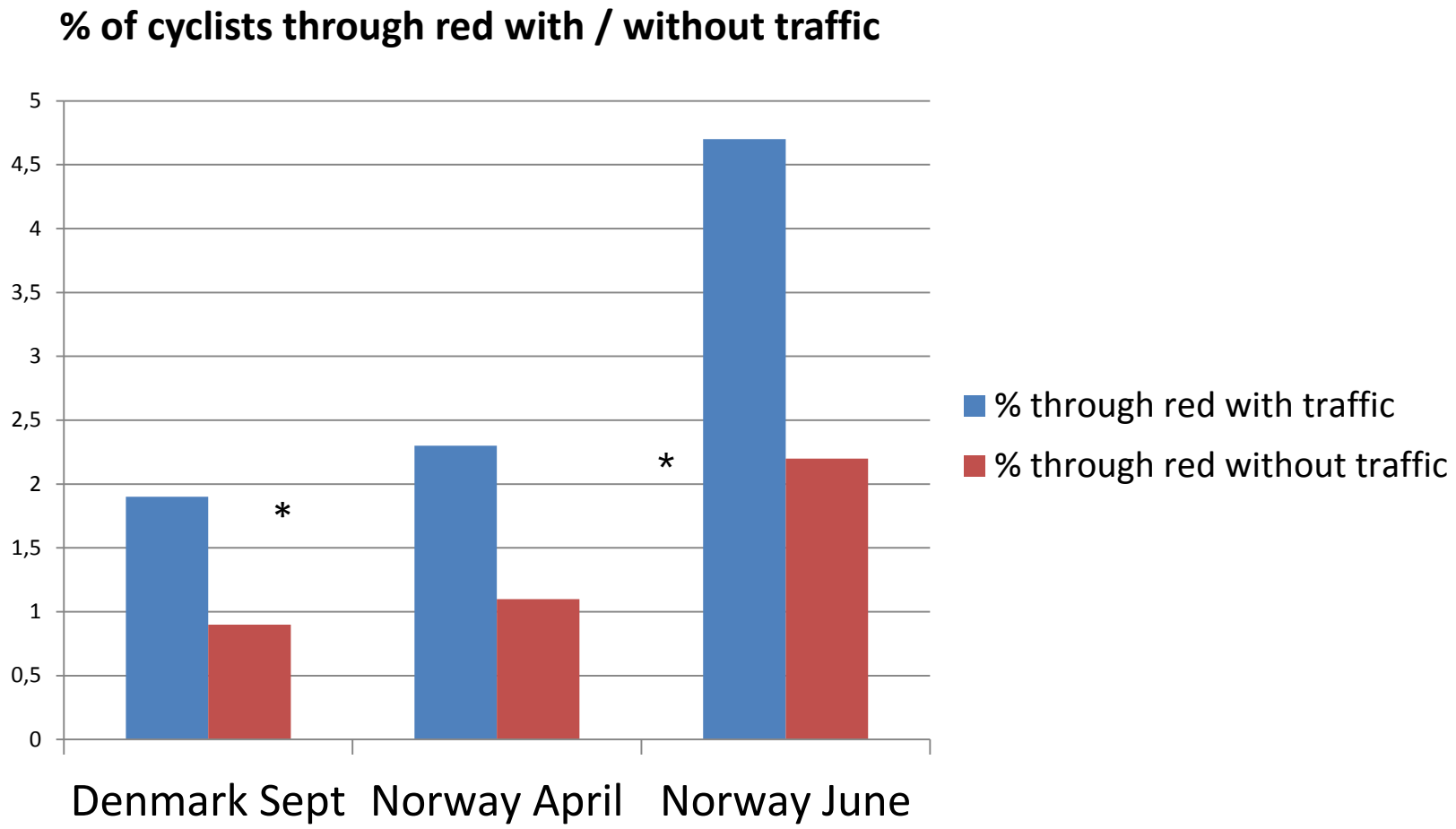
Violations: cyclists through red



* Total: $X^2(2) = 330.7$, $p = .00$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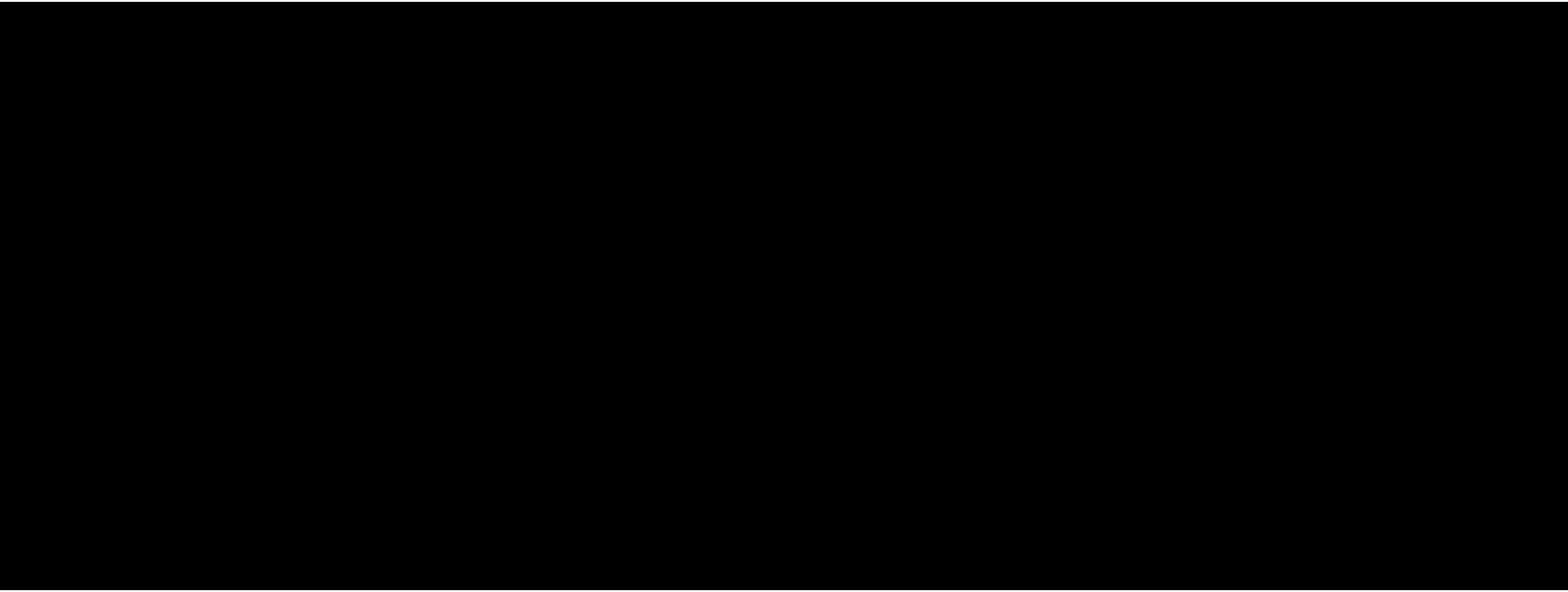
	Light conflicts	Severe conflicts	Total*
Norway April	12 (0.3%)	3 (0.1%)	15 (0.3 %)
Norway June	27(0.2%)	16 (0.1%)	42 (0.3%)
Denmark Sept	12 (0.1%)	8 (0.04%)	20 (0.1%)

*Denmark – Norway April: X^2 (1) = 9.9, p = 0.002

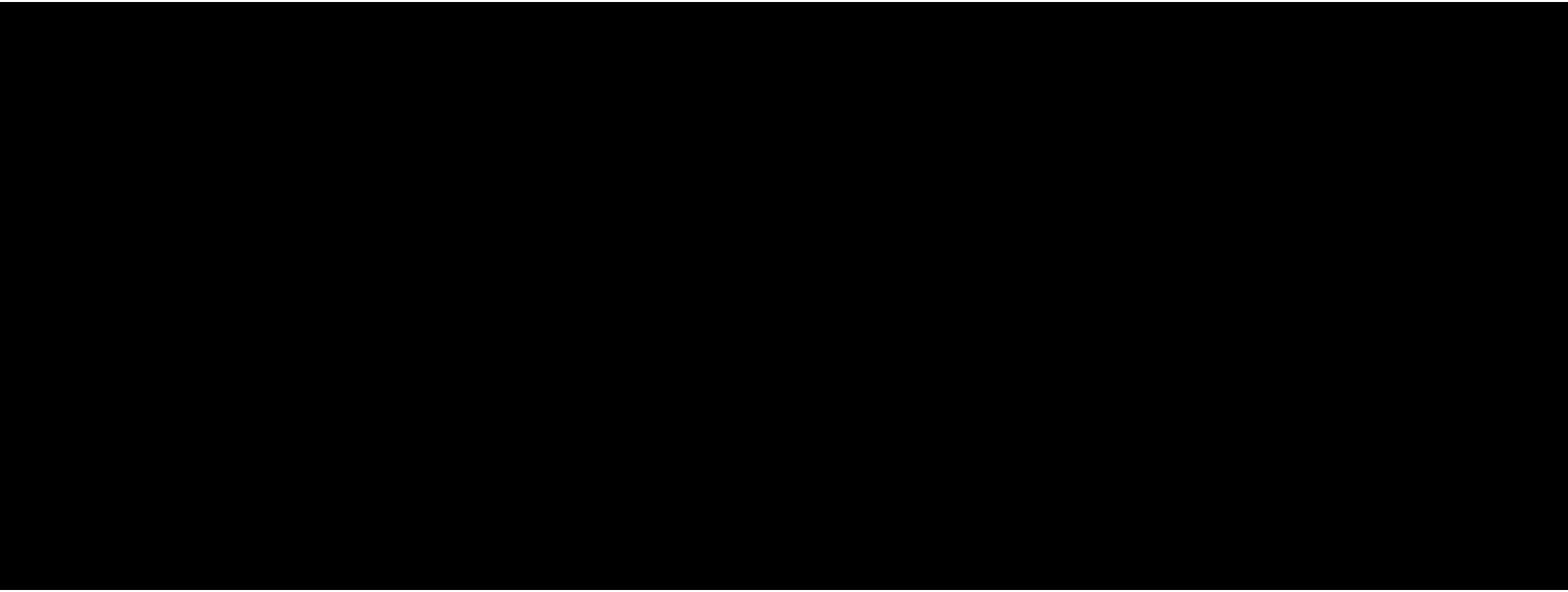
*Denmark – Norway June: X^2 (1) = 12.0, p = 0.001

*Norway April – Norway June: NS

Car not yielding: conflict level 4



Minivan not yielding: conflict level 3

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Car on red: conflict level 3


Exposure

- The chance of a conflict between a cyclist and a car is dependent on the number of possible critical encounters with cars.
- How to calculate….?
- Number of encounters
- Most interesting conflict in terms of interplay and attention are yielding conflicts.


	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 %

Norway June – Denmark: Likelihood Ratio* (1) = 20.6, p = .000

*1 cell has expected count less than 5, X^2 can not be used.


Summmary & conclusion

- Long-term interplay effect: more conflicts in Norway than in Denmark
- Norwegian cyclists seem to be more ‘risk taking’, even more in June
- No short term ‘attention’ effect.
- More data…..


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Thank you!

Any questions?

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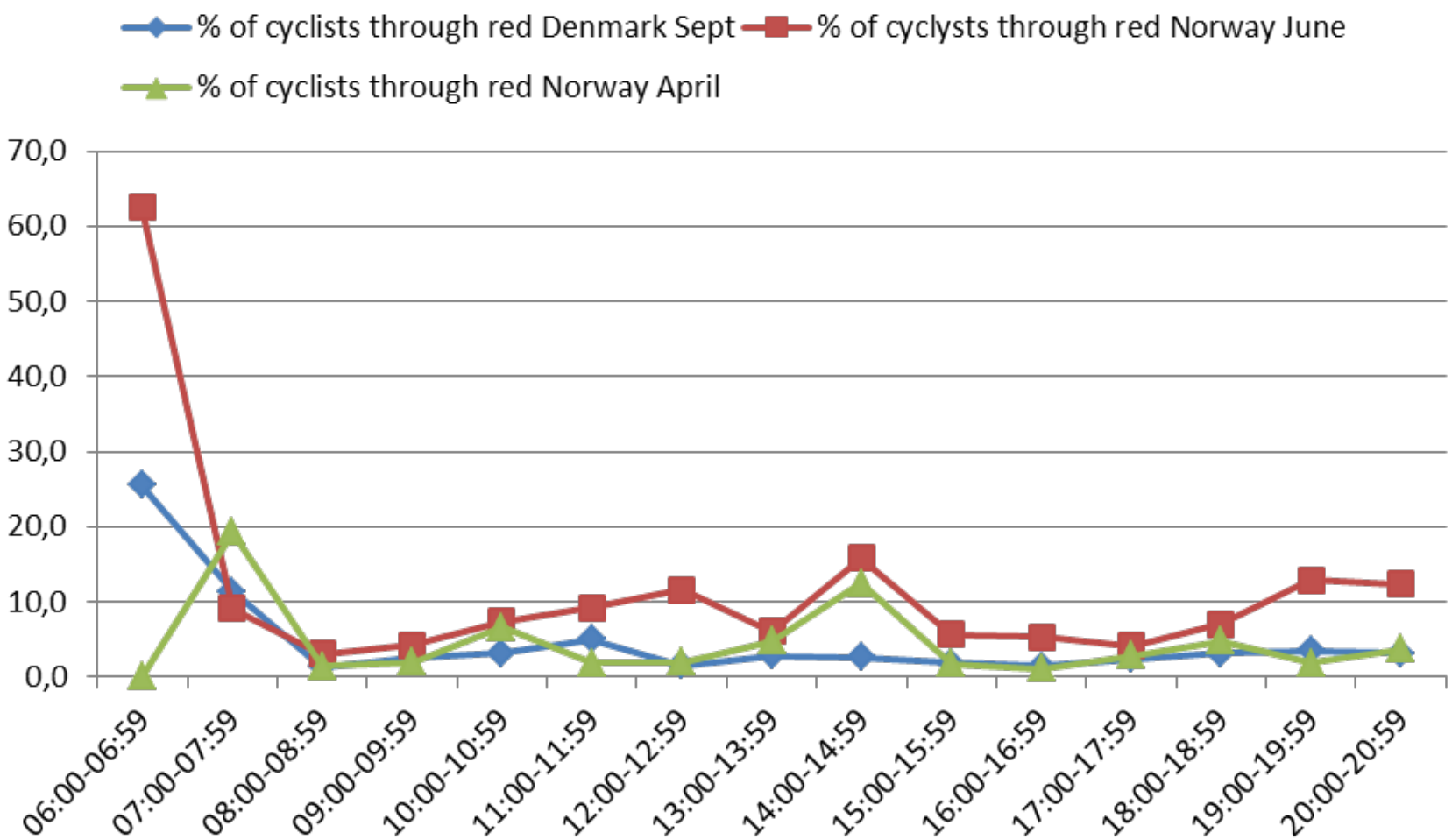
2010	Person km (million)	Killed (police records)	Injured (police records)	Risk
Norway	821	7	505	0.62
Denmark	2470	26	688	0.30
The Netherlands	15000	162	5751	0.40


% of cyclists through red during the day
% of cyclists through red Denmark Sept
% of cyclysts through red Norway June
% of cyclists through red Norway April
70,0
60,0
50,0
40,0
30,0
20,0
10,0
0,0
06:00-06:59
07:00-07:59
08:00-08:59
09:00-09:59
10:00-10:59
11:00-11:59
12:00-12:59
13:00-13:59
14:00-14:59
15:00-15:59
16:00-16:59
17:00-17:59
18:00-18:59
19:00-19:59
20:00-20:59


Number of cyclists and motor vehicles

	Norway – April 2013	Norway – June 2013	Denmark – Sept 2013
Nr of cyclists (6.00-21.00)	930	2.940	3.474
Nr of motor vehicles (6.00-21.00)	19.620	26.521	17.052


	Cyclists through red with traffic	Cyclists through red without traffic	Cyclists through red
Norway April	106 (2.3%)	53 (1.1%)	159 (3.4%)
Norway June	698 (4.7%)	322 (2.2%)	1020 (6.9%)
Denmark Sept	335 (1.9%)	151 (0.9%)	486 (2.8%)

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	23	10	8	1	0	1	44
C-C	3	0	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	1	2	1	0	0	0	3
B-P	0	1	0	0	1	0	2
Total	29	13	9	6	2	2	61
Conflict severity							Total
1	7	1	1	2	0	1	12
2	14	6	4	4	1	1	30
3	6	6	4	0	0	0	16
4	2	0	0	0	1	0	3
5	0	0	0	0	0	0	0


Overall Severity of conflict according to DOCTOR

extent of consequences	Probability of collision								
letselernst	TTCmi n						PET		
	geen	>2	2-1.5	1.5-1	1.0-0.5	0.5-0	>1.0	1.0-0.5	0.5-0
zeer klein	X	X	X	1	1	2	X	X	1
klein	X	X	1	2	2/3	3	X	1	2
redelijk	X	1	2	2/3	3	4	1	2	3
groot	1	2	2/3	3	4	5	2	3	4/5

Extent of consequences based on type of road user (mass, vulnerability), who is approaching who, approach speed, controlled or uncontrolled evasive action (swerving, braking, accelerating, etc.)


Discussion

- More data are needed.
- Do we need encounter counts to measure exposure?
- Safety in Numbers mostly applies to the interaction between cars and cyclists. What about cyclist-cyclist interactions? There might be a Safety in optimal Numbers effect?
- It is not only a matter of increasing the number of cyclists.


Method

- Different intersections (long-term SIN effect?)
  - Norway
  - Denmark
- Different timings (short-term SIN effect?)
  - Norway April
  - Norway June
  - Camera observations
- Traffic counts, Traffic conflicts, Red light running