Human factors in traffic safety promotion

dr. Pål Ulleberg

Institute of Transport Economics, Oslo

Historic overview- theories of road accident causation

- **1930- 1950** "Accident proneness" → small number of drivers responsible for most accidents
- **1950-1960** Causal theories: In-depth studies of single accidents. The cause of the accident → Human failure
- **1960-1970** Systems theory → Traffic system inadequate
- **1970-1985** Compensation theory → Motivation
- **1985-** "Postmodern reaction" → Safety culture

Accident proneness

The belief that most road accidents are caused by a small number of persons.

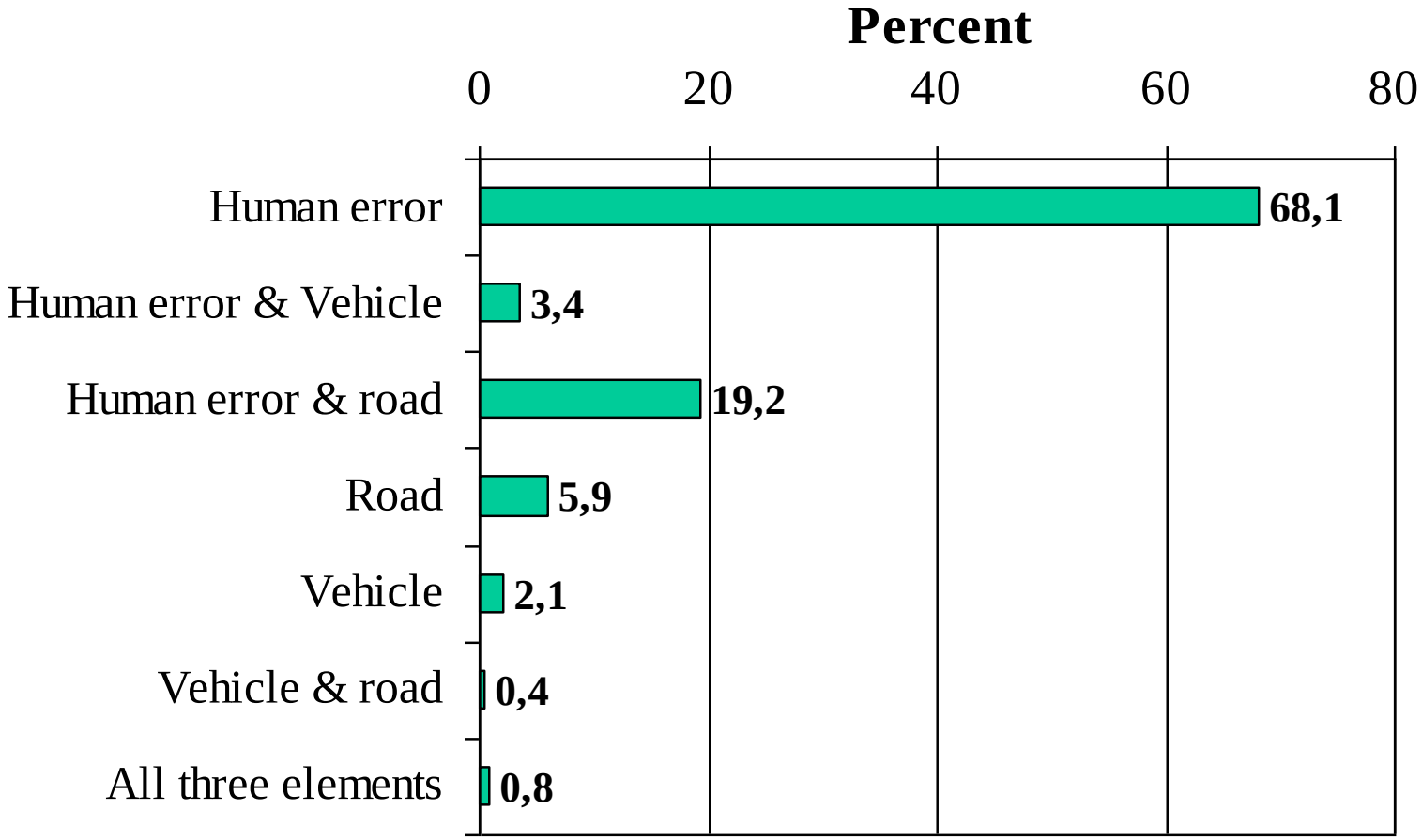
These persons are believed to:

- possess certain personal characteristics (Farmer & Chambers, 1939)
- be socially maladjusted – ”A man lives as he drives” (Tillman & Hobbs, 1949)
- be subconsciously motivated to conduct errors causing road accidents in order to punish oneself (Ranney, 1944)

- Low evidence for this theory – most accidents are caused by drivers with no prior record of accident involvement during the last years.
- Heavily influenced by the fundamental attribution error?
- Still, certain personality characteristics related to increased accident risk

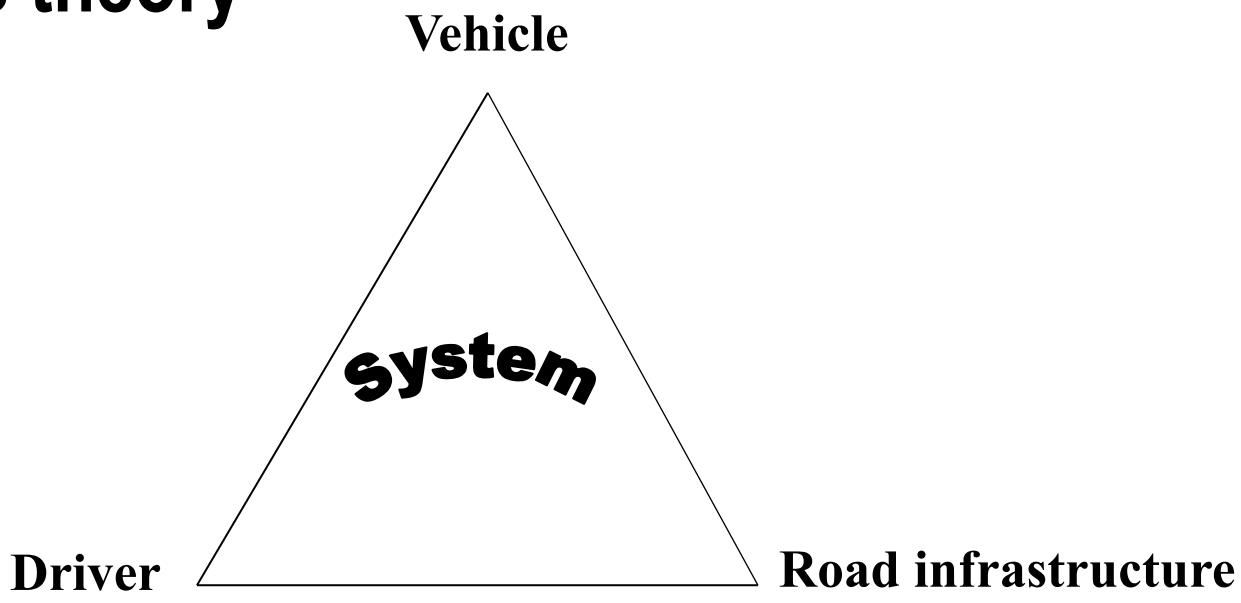
In –depth studies of accidents

Human error, the vehicle or the road as the cause of accidents?



Elvik et al. 1997

Systems theory



- Road accidents is seen as a failure of the hole traffic system (interaction between the three elements) rather than a failure of the driver

Systems theory, cont.

- The driver is a victim - the demands the traffic system puts on the driver is too complex for the driver's limited capacity of processing information
- The systems must be designed less complex, thereby *prevent* errors from occurring
- "The energy and barriers perspective": The system must also *reduce* the negative consequences of errors, i.e. introduce safety margins which allows the driver to conduct errors without being hurt too seriously

Willam Haddon – adminstror of NHTSA from 1966 imposed the following regulations for new cars:

1) Seat belts for all occupants
2) Energy-absorbing steering column
3) Penetration-resistant windshield
4) Dual braking systems
5) Padded instrument panel

➔ All measures in accordance with the energy and barrier perspective

➔ Systems theory also a central thought in ”Vision Zero”

"**Motivation reaction**" to systems theory

- **The systems theory approach treats the driver as a passive responder in his environment.**

- **The evidence is that he is in fact an active participant, regulating his/her level of preferred risk**

- **Risk compensation/ behavioural adaptation: Actors or operators within a system may take advantage of safety measures in other ways than to increase safety**

- **Two basic forms of compensation to road safety measures:**
  - **Increased speed**
  - **Reduced attention**

” … more efficient brakes on an automobile will not in themselves make driving the automobile any safer. Better brakes will reduce the absolute size of the minimum stopping zone, it is true, but the driver soon learns this new zone and .. he allows only the same relative margin between field and zone as before.”

Reference: Gibson J. J. & Crooks L. E. (1938): A theoretical field analysis of automobile driving. The American Journal of Psychology, 51, 453-471

Important contributions to the debate on risk compensation:

1) Samuel Peltzman (1975): "Safety regulations for cars increase the risk for unprotected road users"

2) Gerald Wilde (1982): Road users have a "target level of risk" – i.e road users compensate for any safety measure

3) Leonard Evans (1985): Risk compensation is an empirical question; will vary for different safety measures.

4) OECD (1990): Behavioural adaptation – "state of the art"

Empirical evidence of risk compensation from road safety measures:

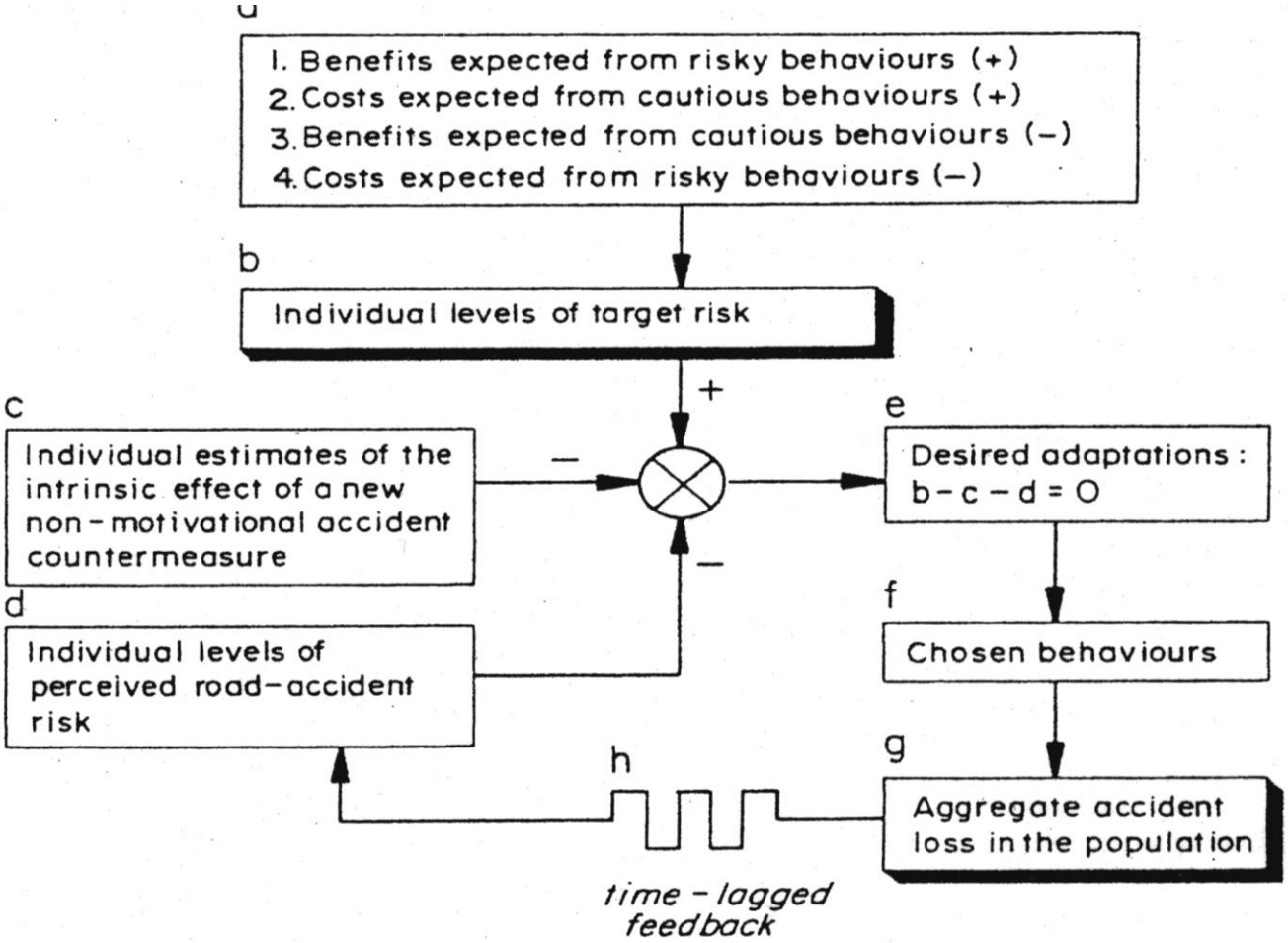
1) No compensation: The actual safety effect is equal to the engineering estimates: Seat belts, air bags

2) Partly compensation: The actual safety effect is less than engineering estimates: Studded tires, road lighting

3) Perfect compensation: The actual safety effect is zero because of risk compensation: Light road surface

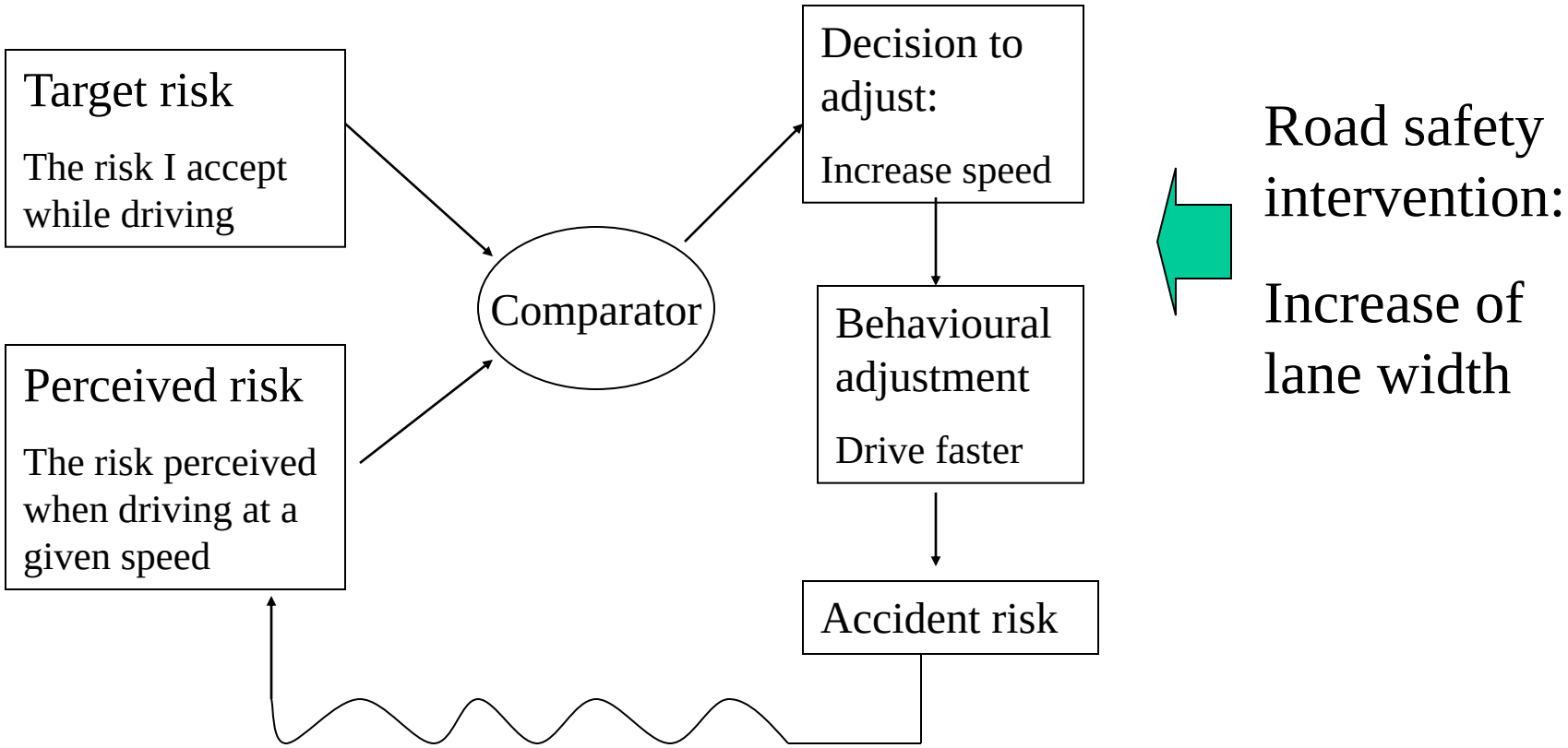
4) Perverse compensation: The actual safety effect is less than before the implementation of the safety measure: Anti-skid driving course for males

Wilde's model of risk homeostasis:



Source: Wilde G. J. S. (1982): The theory of risk homeostasis: Implications for safety and health. Risk Analysis 2: 209-225.

A simplified version of the risk homeostasis theory



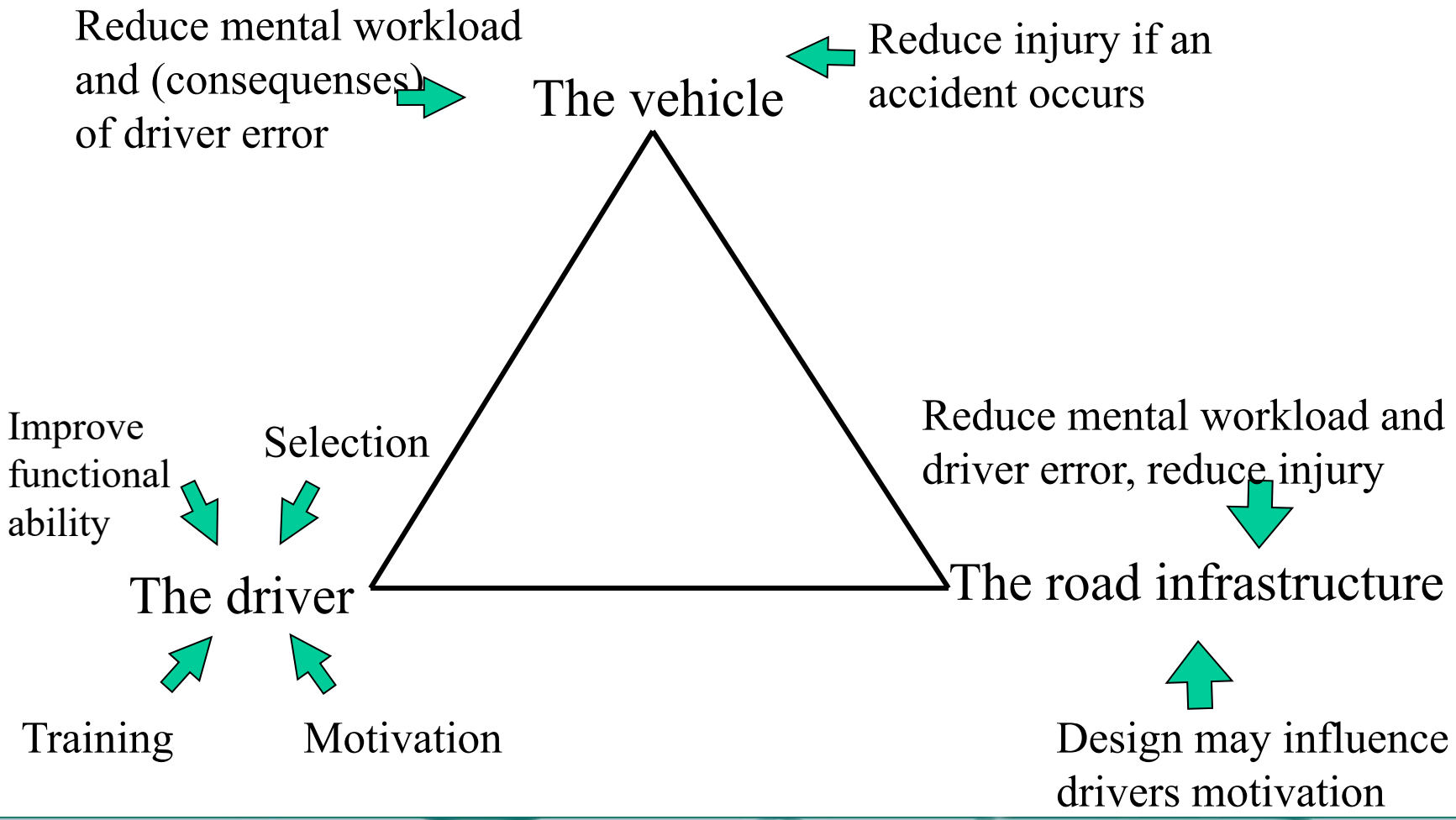
Risk compensation in other areas o transportation

- Air: ”Situation awareness”
- Railway: ”ATC – behaviour”
- Sea: ”Radar-assisted accidents”

Preliminary conclusion

- The systems theory approach may be well suited for avoiding unintentional driver errors, but:
- The driver must be seen as an active participant, not a passive responder of the system
- New safety measures will not automatically result in actual safety benefits
- How to increase the safety margins of the system without drivers' compensating for it?

Holistic approach to accident prevention



Three components of driver behaviour which may cause accidents

Based on Reason (1990), further developed by Parker et al. (1995):

- Slips and lapses
- Errors (mistakes)
- Violations

Slips and lapses	Technical mastery	Choosing the wrong gear	Influenced by:
Errors (mistakes)	Reading the road, hazard perception	Misjudge the distance to an approaching car Fail to notice a "Wrong Way" Sign	Cognitive and motor skills
Violations	Driving expression of underlying motivation	Speeding, close following, dangerous overtaknings	Motivational and social factors

Avoiding errors and slips /lapses

- Slips/lapses and errors are primarily influenced by motoric, perceptual, attentional, or judgmental processes
- Avoid errors, slips and lapses through making the elements of the traffic system less demanding:
  - The driver –automatization of skills, improving functional limitations
  - The vehicle – passive and active safety (injury reduction and accident avoiding), man-machine interaction
  - The road infrastructure – less demanding

Violations

- seem to be based on motivational and/or social factors
- changing people's beliefs and/or motives central for avoiding violations
- e.g. attitude campaigns, police surveillance, speed camera
- Or influence the driver subconsciously through "smart-design" of the road environment

Influencing the driver through modification of the road infrastructure

- Avoiding errors and violations

”Positive guidance”

(Alexander and Lunenfeld, 1986)

- Systematic procedure for presentation of driver information at problem sites
- Based on driver performance data, video recordings from ”drivers’ eye” point of view, and other sources
- Expectancy Analysis and Review: Method for identifying sources of expectancy violations and possibilities of retructuring expectancies



Drivers need time for *perception*, *decision* and *reaction*

- 'Recognition error' frequent (> 50 %) cause of accidents
  - inattention (e.g.: 'looking but not seeing')
  - improper lookout
- Allow for sufficient perception-reaction time
  - what is sufficient?
  - current standards of 2.0 sec for intersection sight distances may be to low to accommodate elderly drivers

Drivers have *limited capacity* for information processing

- Important information may be missed
- Missing or misinterpreted signs, markings, alignment may result in wrong decisions and inadequate speed adaptation
- Amount of relevant information should therefore be limited

Several exits close to each other

- Original solution



Several exit close to each other

- New and improved solution





Drivers' *attention is selective*

- Two modes of information selection
- top-down vs. bottom-up processing
  - searching actively for information (top-down) – determined by expectancies
  - information catching the driver's attention (bottom-up) – determined by attributes of the information
- *Distraction* is selective attention to the wrong information

Satisfy information needs

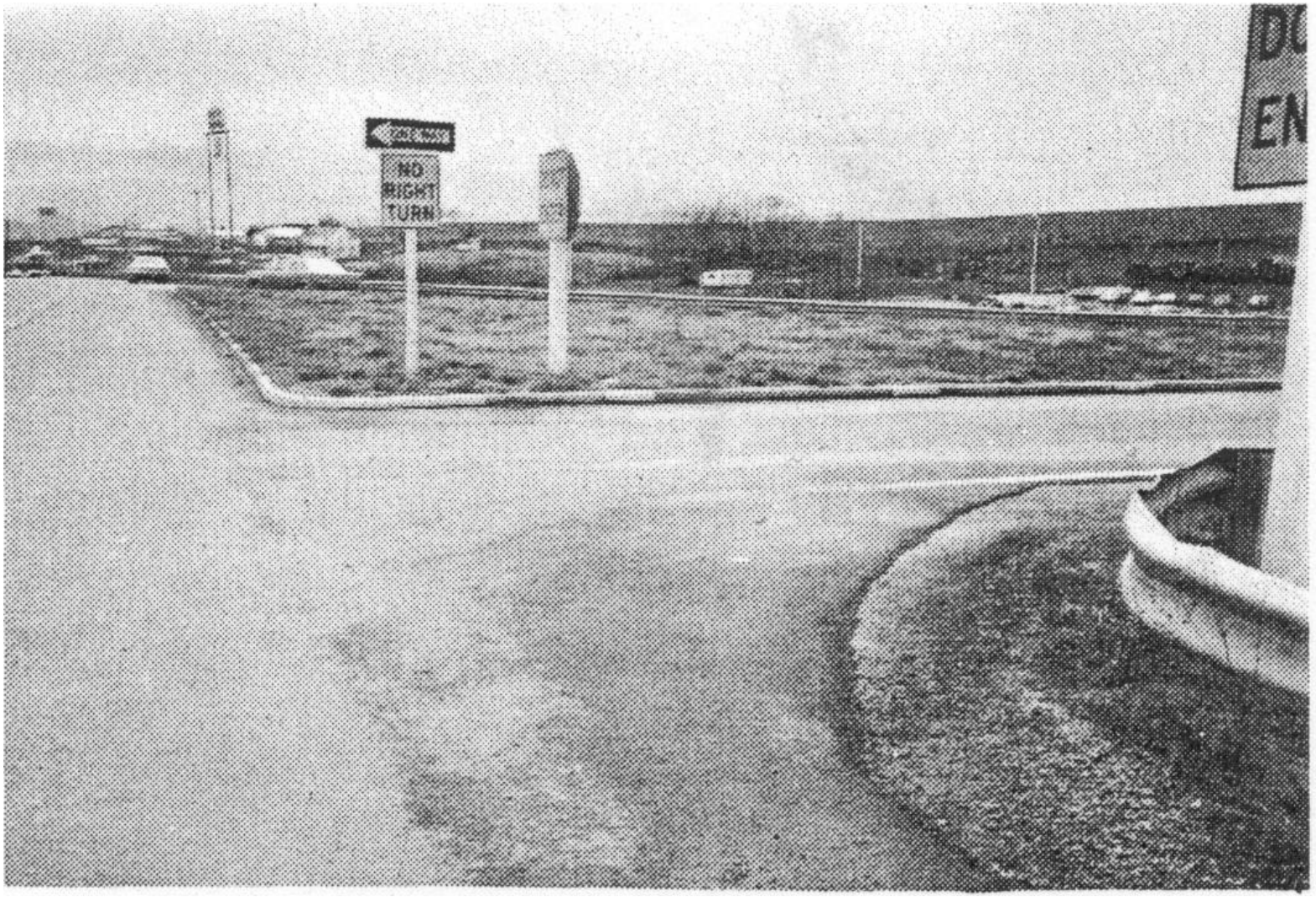
- Avoid irrelevant information that may distract drivers' attention (e.g. roadside advertisement boards)
- Make relevant information **CONSPICUOUS**
  - position
  - size
  - colour/contrast
  - motion

Conspicuity or camouflage?

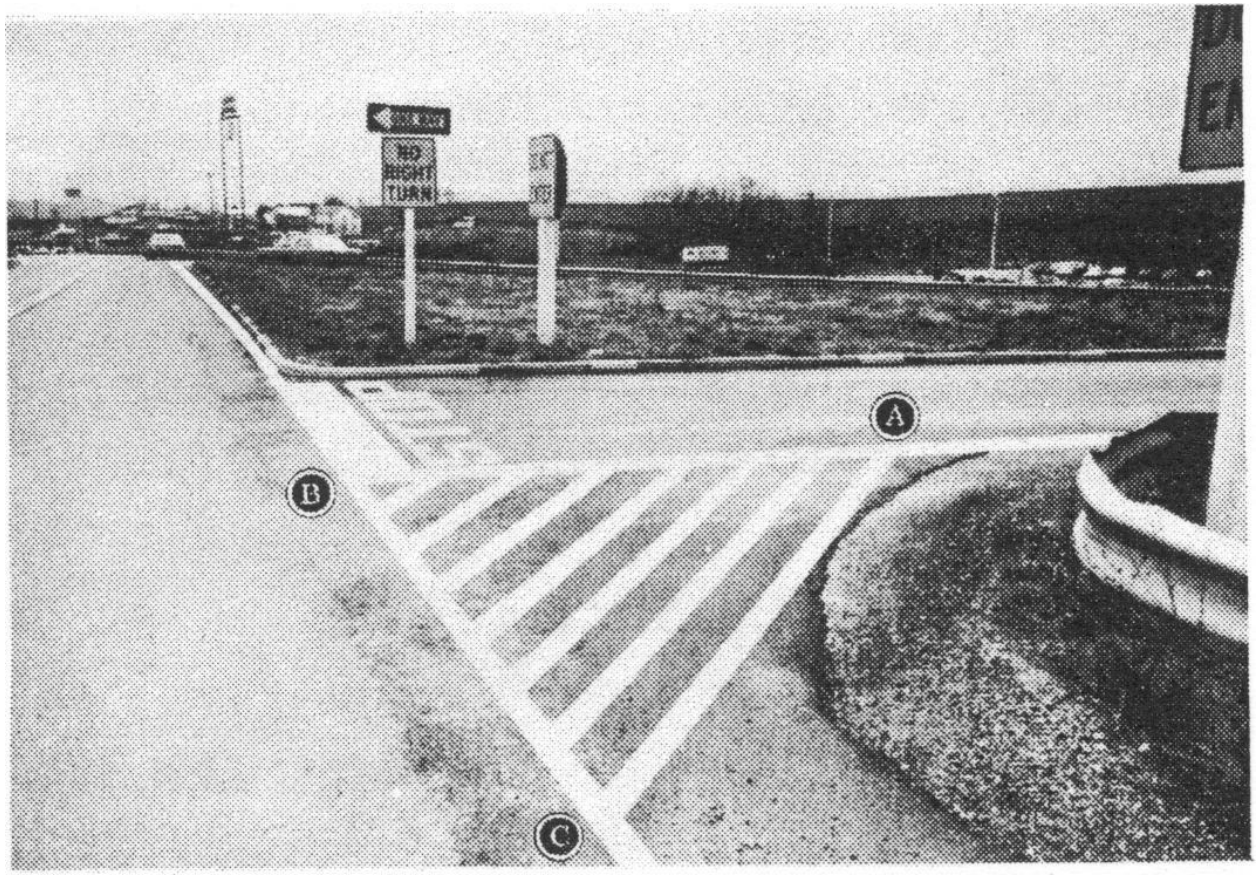




Exit from highway (to the right) – improper solution



Problems can to some extend be solved with better road marking



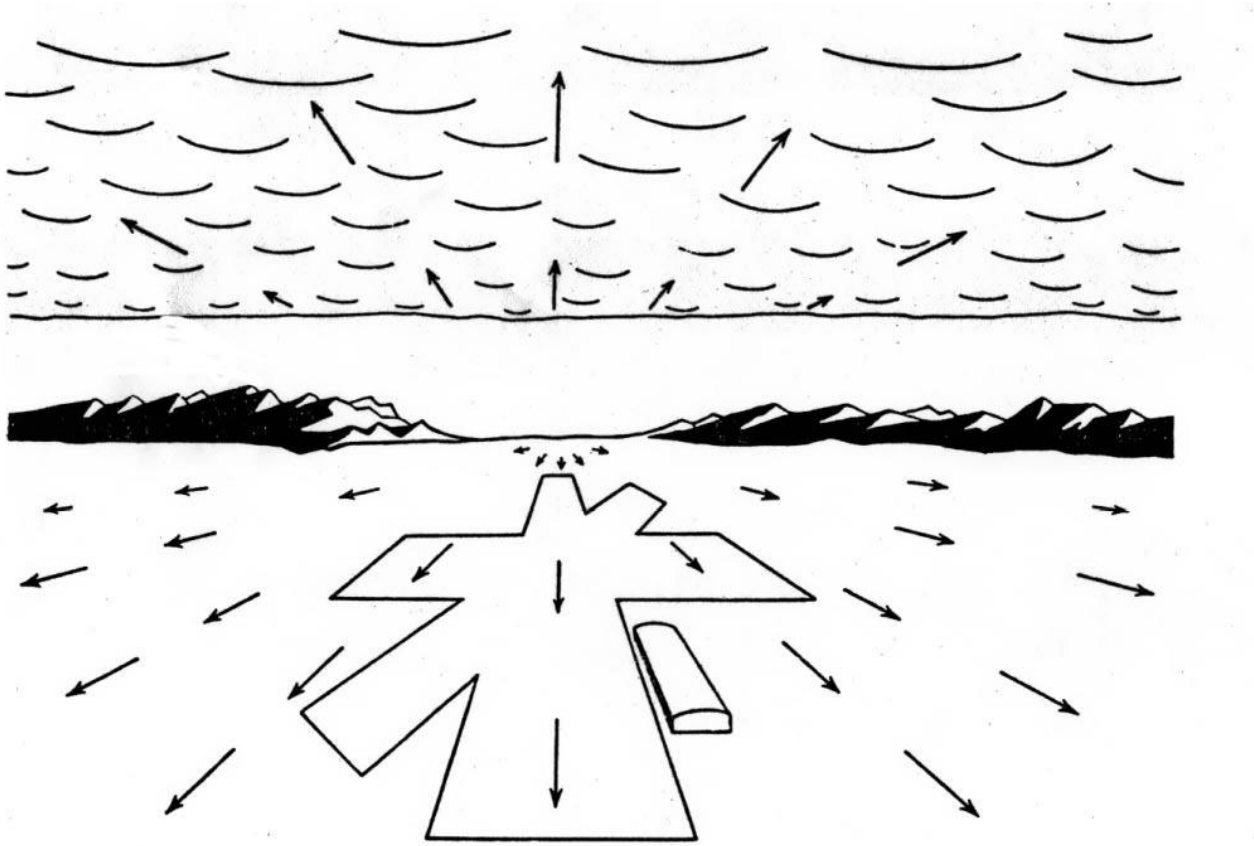
Increasing safety margins without compensation

Some examples of speed reduction through modifications of the road enviroment

Speed perception

- Drivers generally underestimate their speed
- Several perceptual (mostly visual) cues determine the feeling of speed:
- ”Retinal streaming” (Gibson, 1950)
  - optical expansion of objects in the visual field
  - objects in the visual periphery move faster than more centrally located objects

”Retinal streaming”



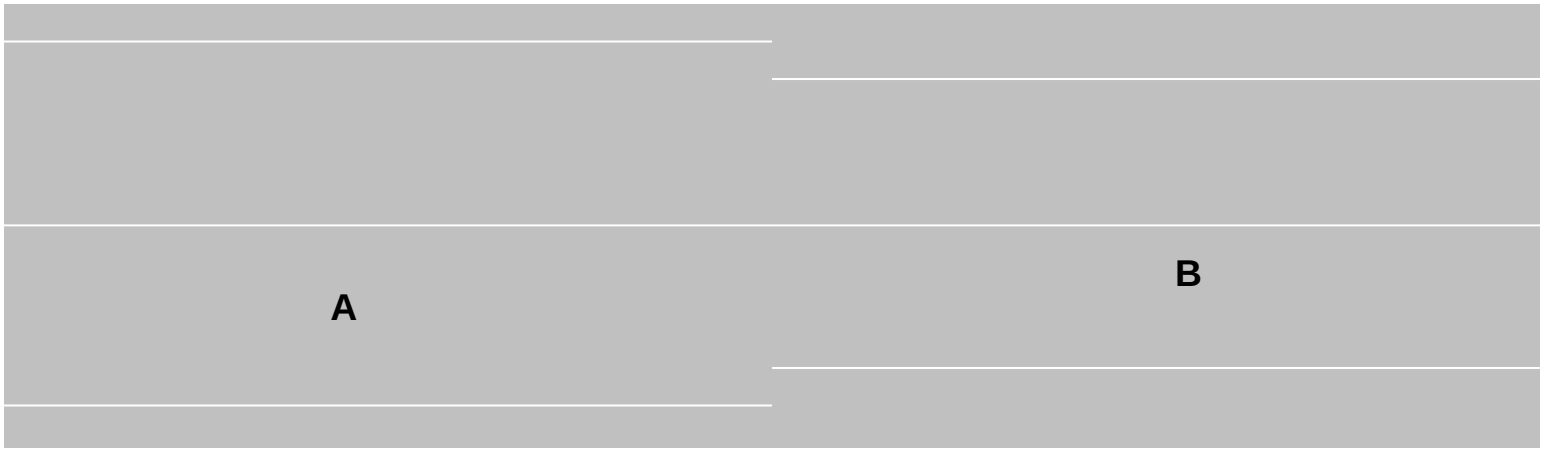
Objects near the road are expected to increase perceived speed



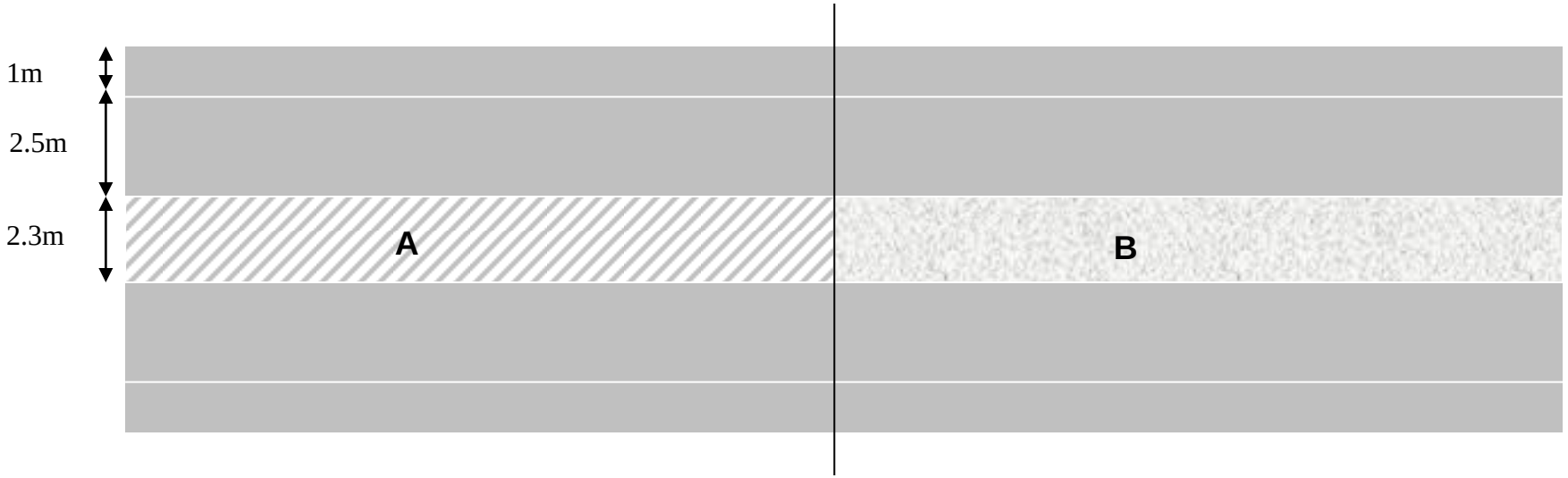
Movement parallax affects speed perception

- Near objects appear to move faster relative to the driver compared to far objects



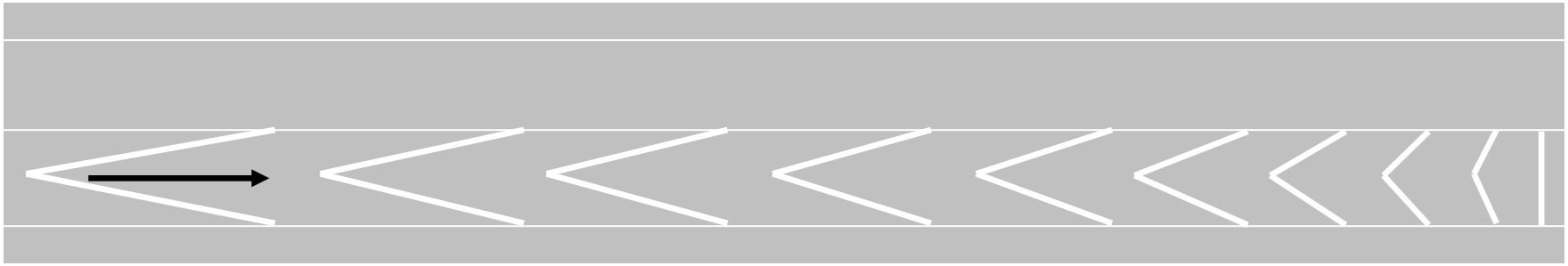


- Narrower lane with and wider shoulder (13-meter road, Sweden)
  - B gives lower speed than A (Lundkvist 1996)
  - Therefore: increased safety margins without compensation



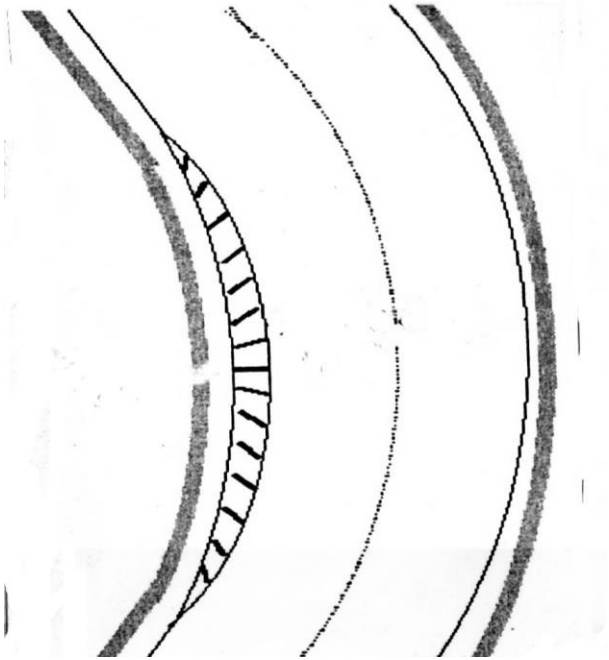
- Study in simulator (Godley m.fl. 1999)
- Width of midline resulted in lower speed
  - Greatest reduction of speed with A
  - Due to periphery visual stimulation?
  - Again: increased safety margins without compensation

- **Wundt's illusion**
  - **Reduces speed**
  - **Uncertain whether this is cause by visual reduction of lane width**
  - **Uncertain whether this is more effective than straight lines across lane**



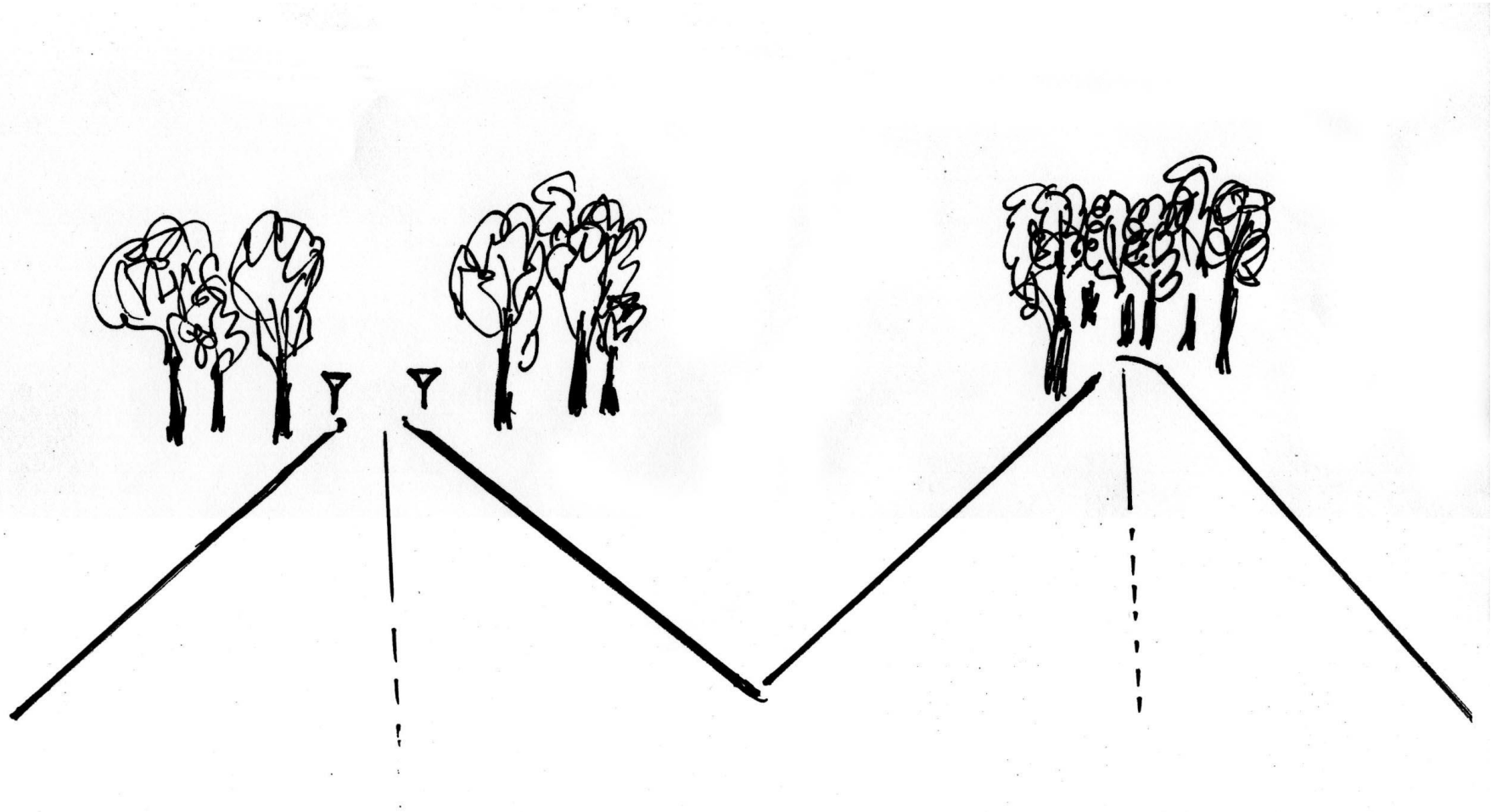
Illusion of tighter curves

- Contradicting results
  - Possible favourable effect in unperspicuous curves



Bump-illusion





Next lecture

- Targeting subgroups of drivers
- Influencing divers motivation through other means than road infrastructure