ATTENTION SELECTION AND TASK INTERFERENCE IN DRIVING: AN ACTION-ORIENTED VIEW

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First International Conference on Driver Distraction and Inattention,

Gothenburg, September 28-29 2009

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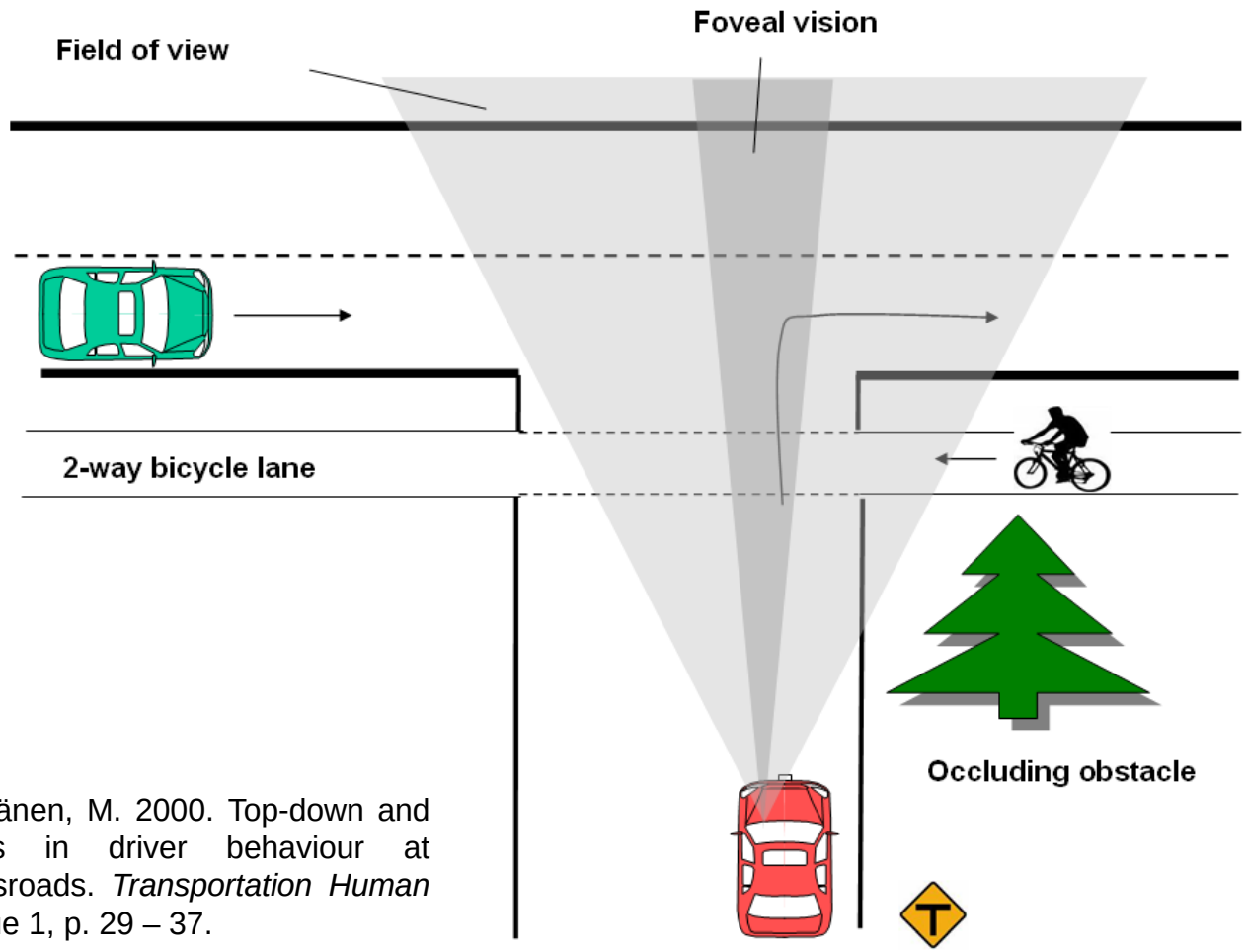
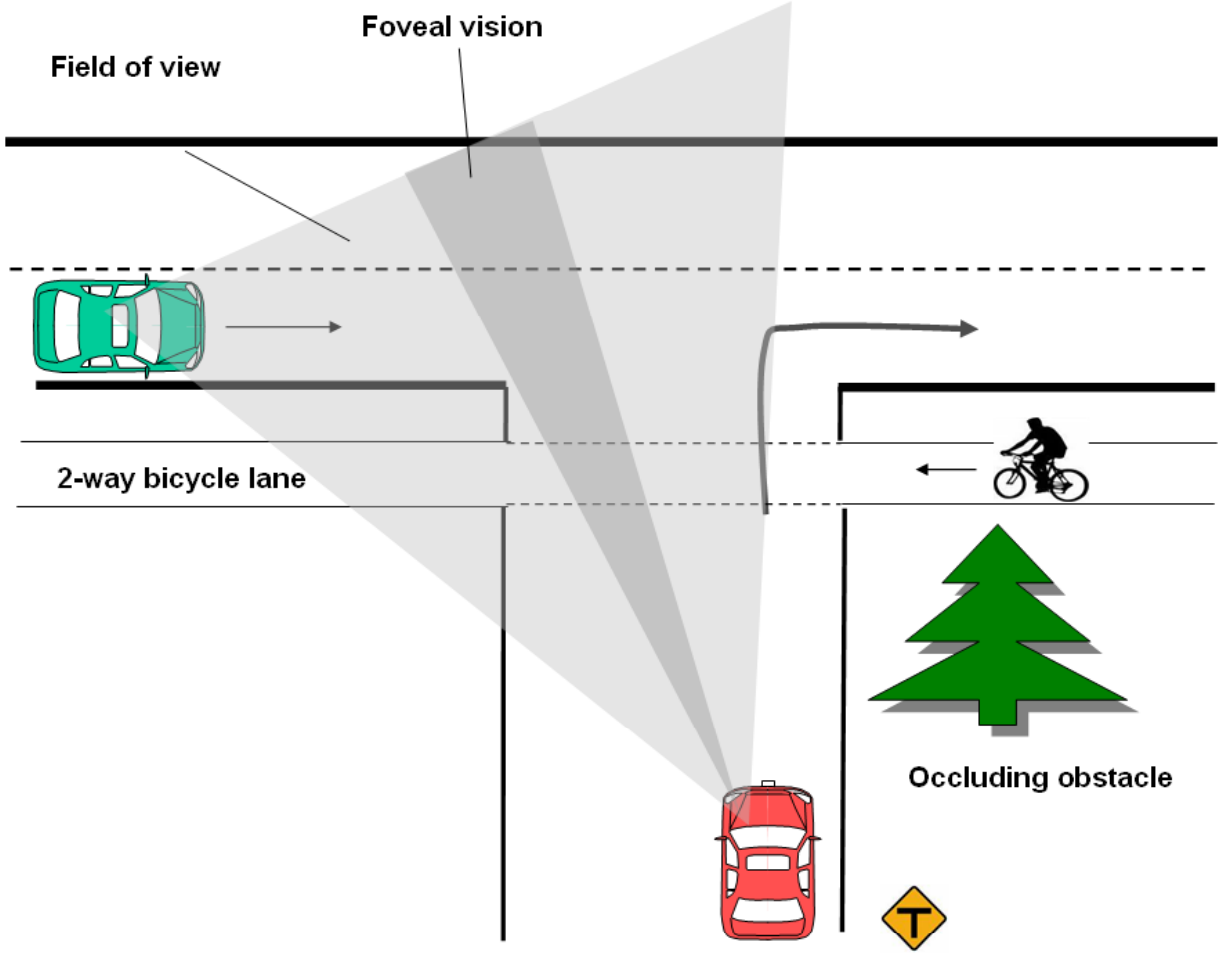
VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

Example scenario: Right turn at T-junction (Summala and Räsänen, 2000)



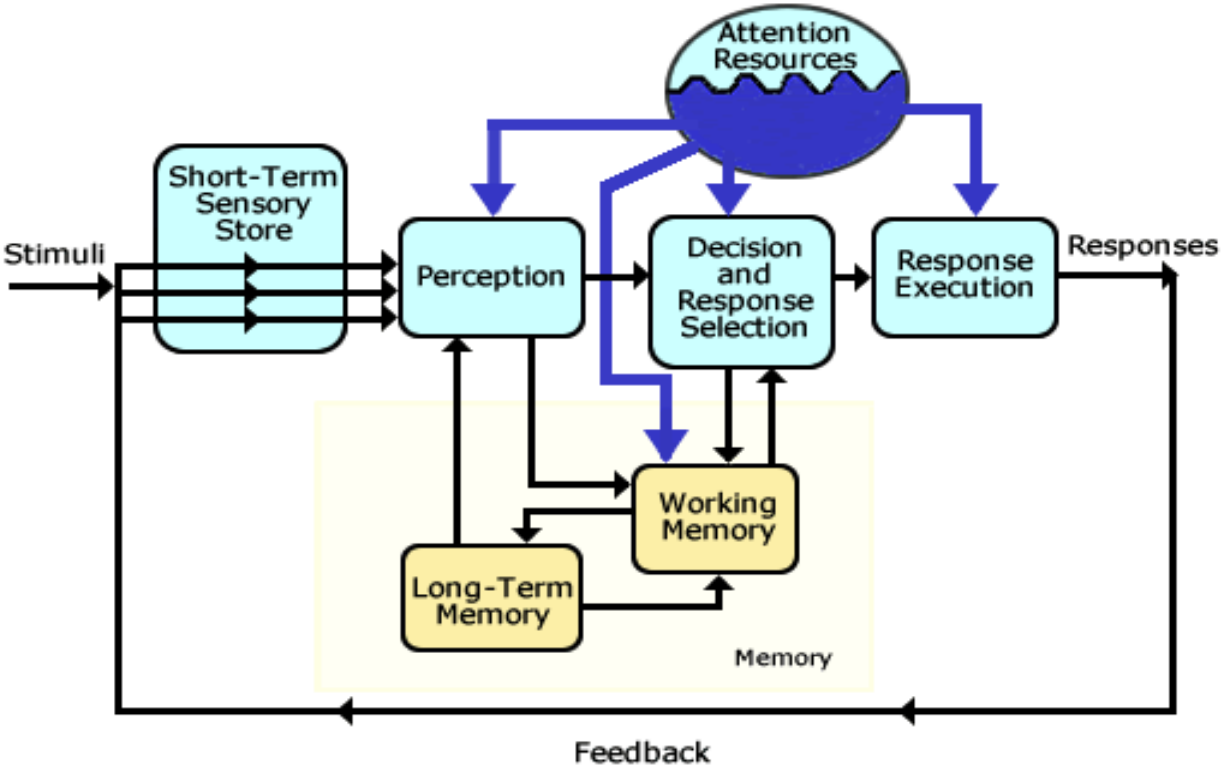
Summala, H. and Räsänen, M. 2000. Top-down and botttom-up processes in driver behaviour at roundabouts and crossroads. *Transportation Human Factors*, Volume 2, Issue 1, p. 29 – 37.

Main finding: Expectancy drives attention- and gaze allocation to the left field of view -> bicyclist missed



Attention selection in real-world driving is active and context-dependent, strongly driven by expecations and task goals

Information processing (IP) models of attention



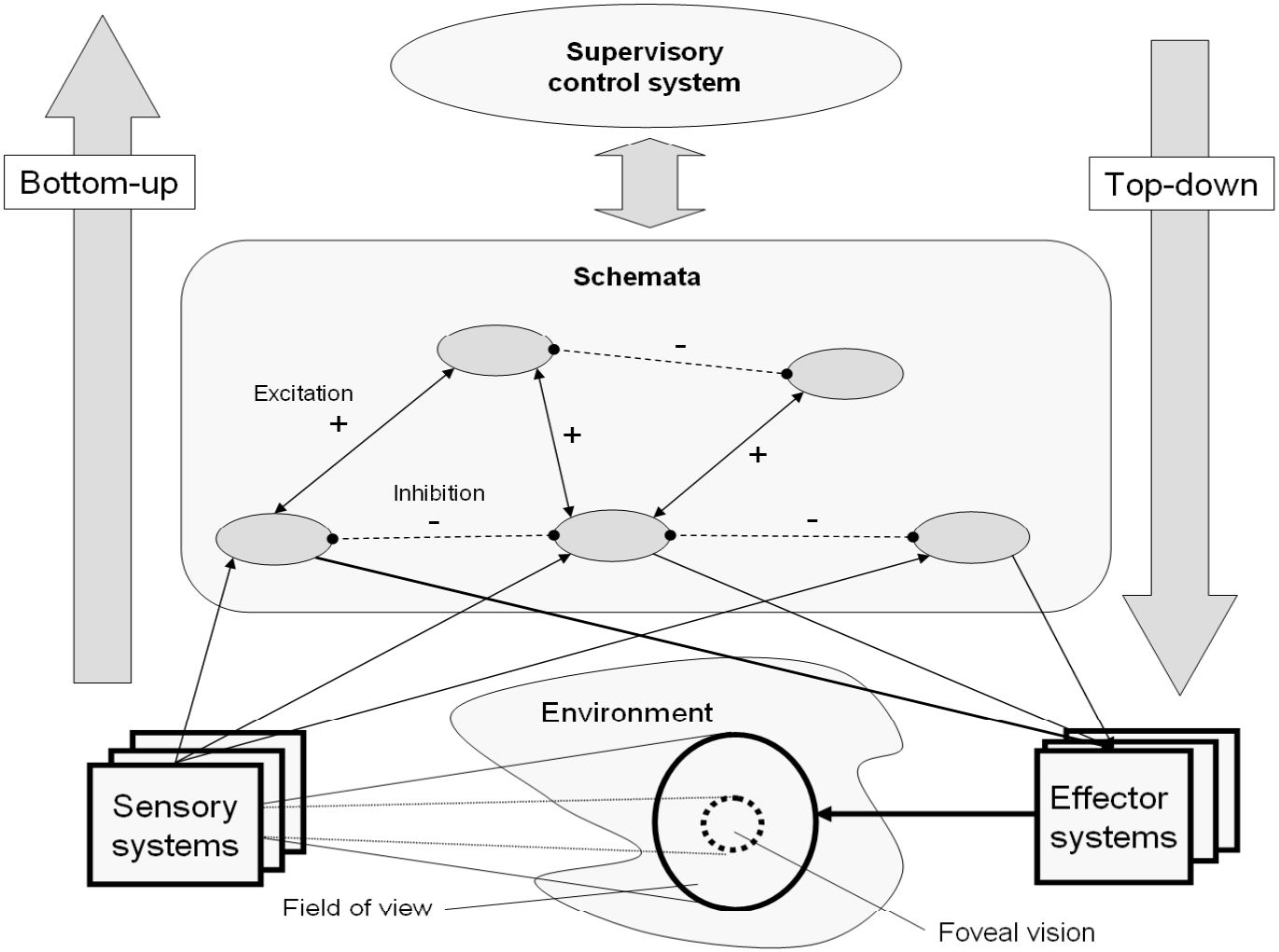
- Views the driver as **passive** receiver of information
- Focus on **limited capacity** rather than selection
- Ignores **active**, goal- and context-dependent aspects of attention **selection**

Alternative: Action-oriented views of attention selection

- Not new - existing line of research in the basic attention literature: Neisser (1976), Norman and Shallice (1986); Allport (1987); Neumann (1987); Milner and Goodale (1995); Cooper and Shallice (2000)
- However: Not yet applied in the applied driving domain

An action-oriented conceptual model of drivers' attention selection

Model overview



Based on Norman and Shallice (1986)

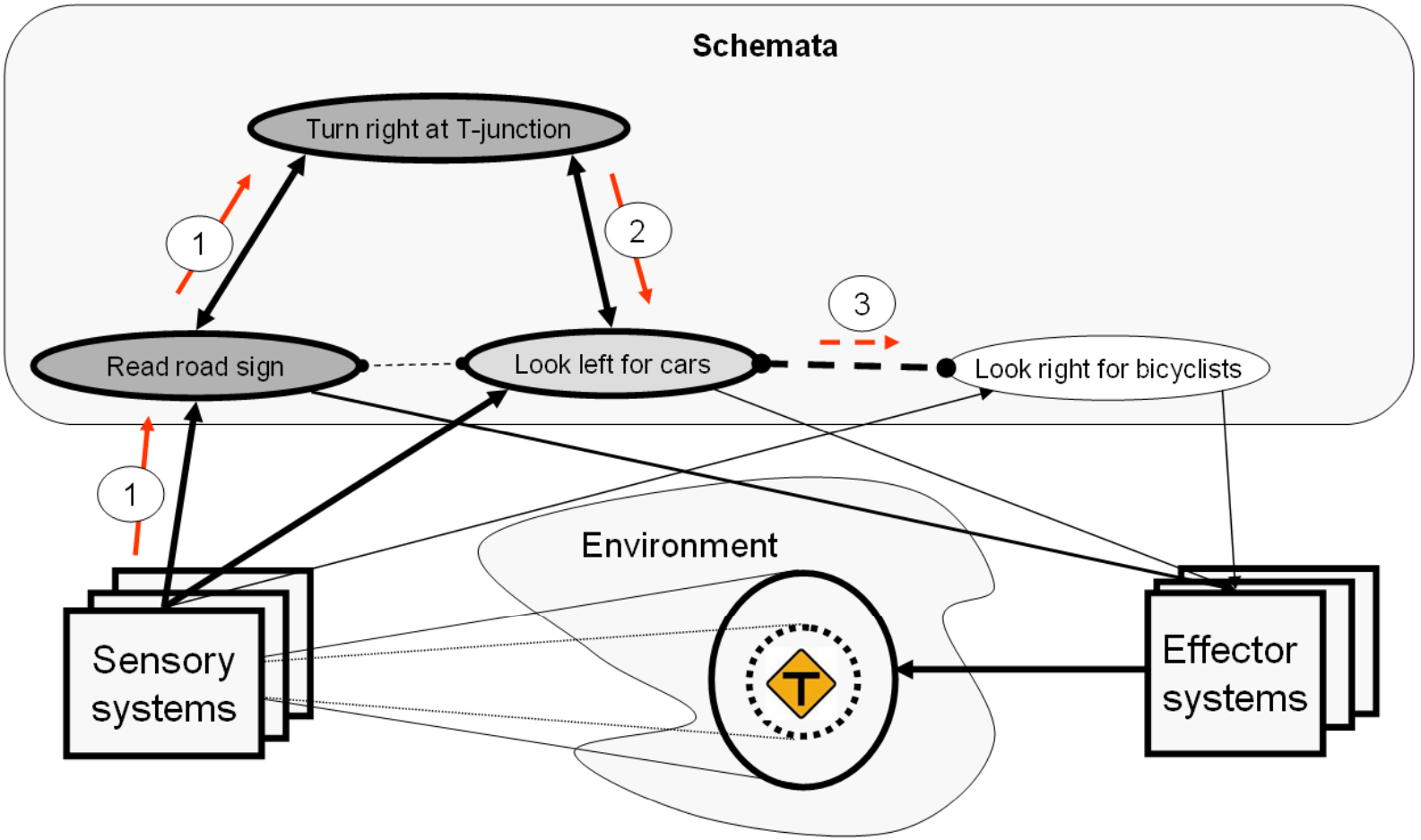
Schemata

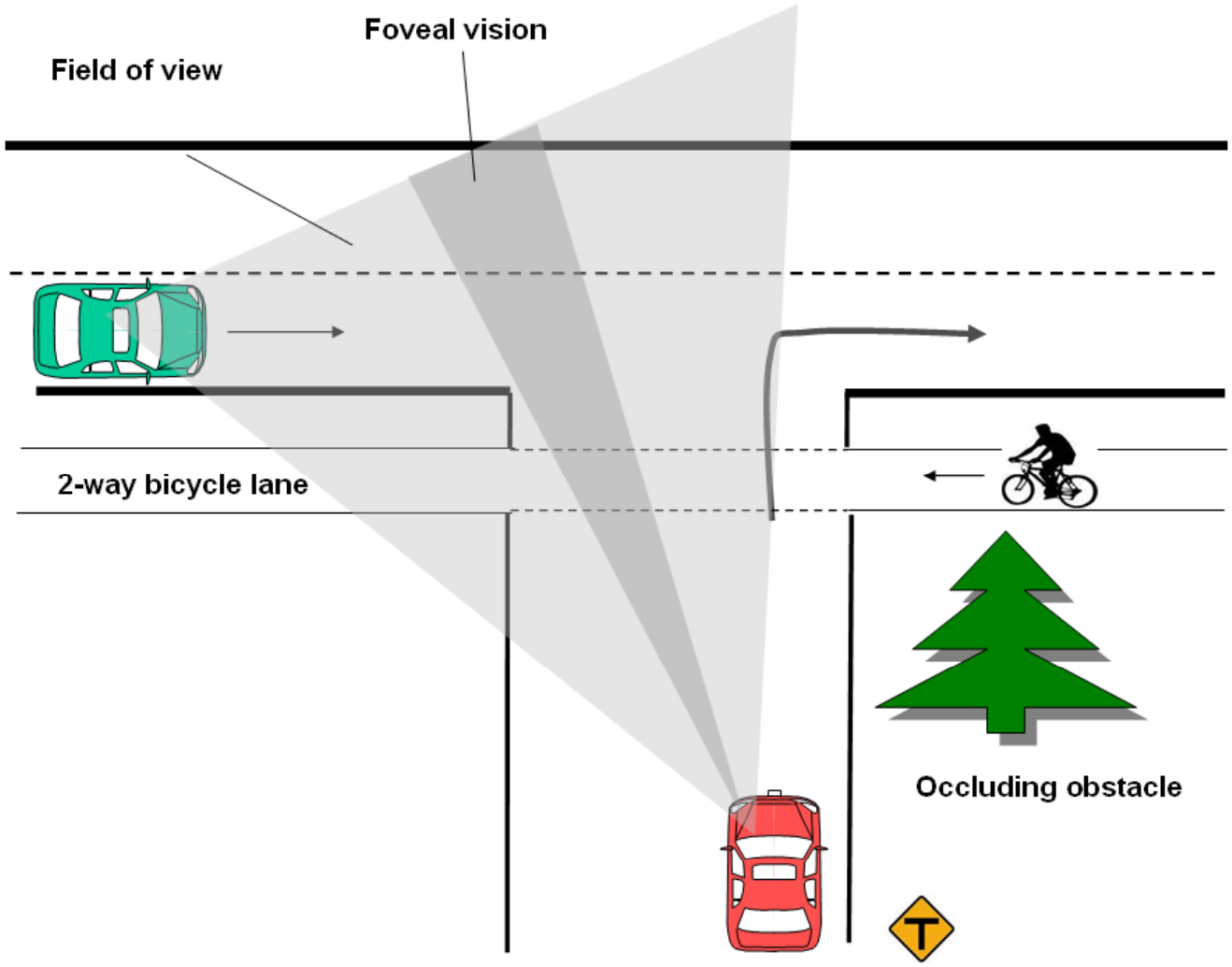
- Represent a simple action or a more complex action pattern (see also Neisser, 1976; Norman and Shallice, 1986; Arbib, 1995)
  - Low-level (sensory-motor) schemata: Steering to keep in lane, braking to lead vehicle, press a button on the dashboard
  - Higher-level schemata: Generic action patterns, situations or task contexts such as “follow the car ahead” or “turn right at an intersection
- Schemata differ in *strength*

Schema selection

- Parallel schemata compete for activation
- Schemata are selected by virtue of their *activation level*
- The selection process involves cooperative and competitive *interactions* between schemata – mutual excitation and inhibition

Example: Anticipative, context-dependent, attention selection in the T-junction scenario

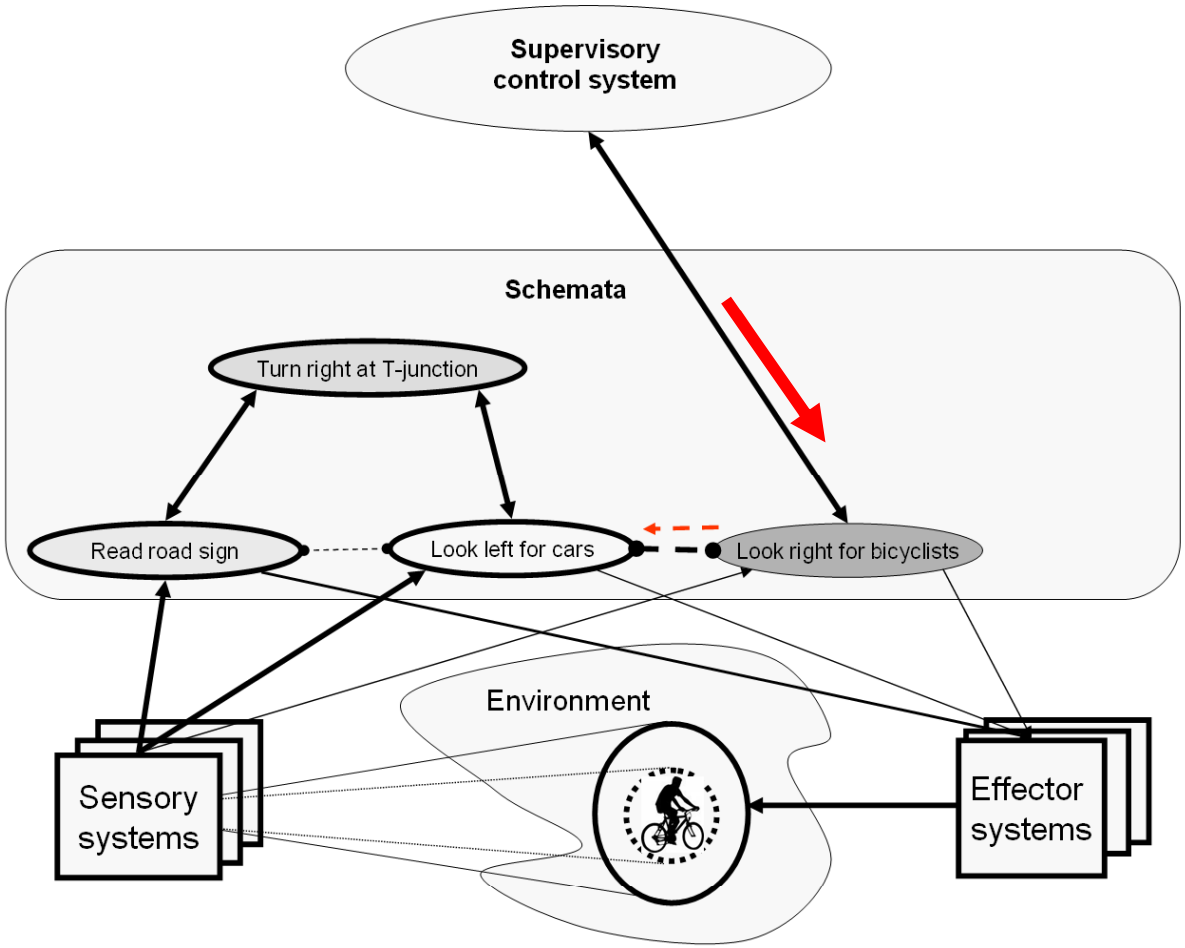



Foveal vision
Field of view
2-way bicycle lane
Occluding obstacle

3. Supervisory control

- If the basic schema selection mechanism were left to work alone -> **stereotyped, inflexible, reactive, behaviour**
- Problems in novel/difficult situations when the required schemata are too weak
- Role of supervisory control:
  - Bias the schema selection mechanism
  - Override inherently stronger schemata in favour of weaker ones when needed
- Requires *energy* -> always deployed with *effort* (c.f. Kahneman, 1973) – "***pay*** attention"…

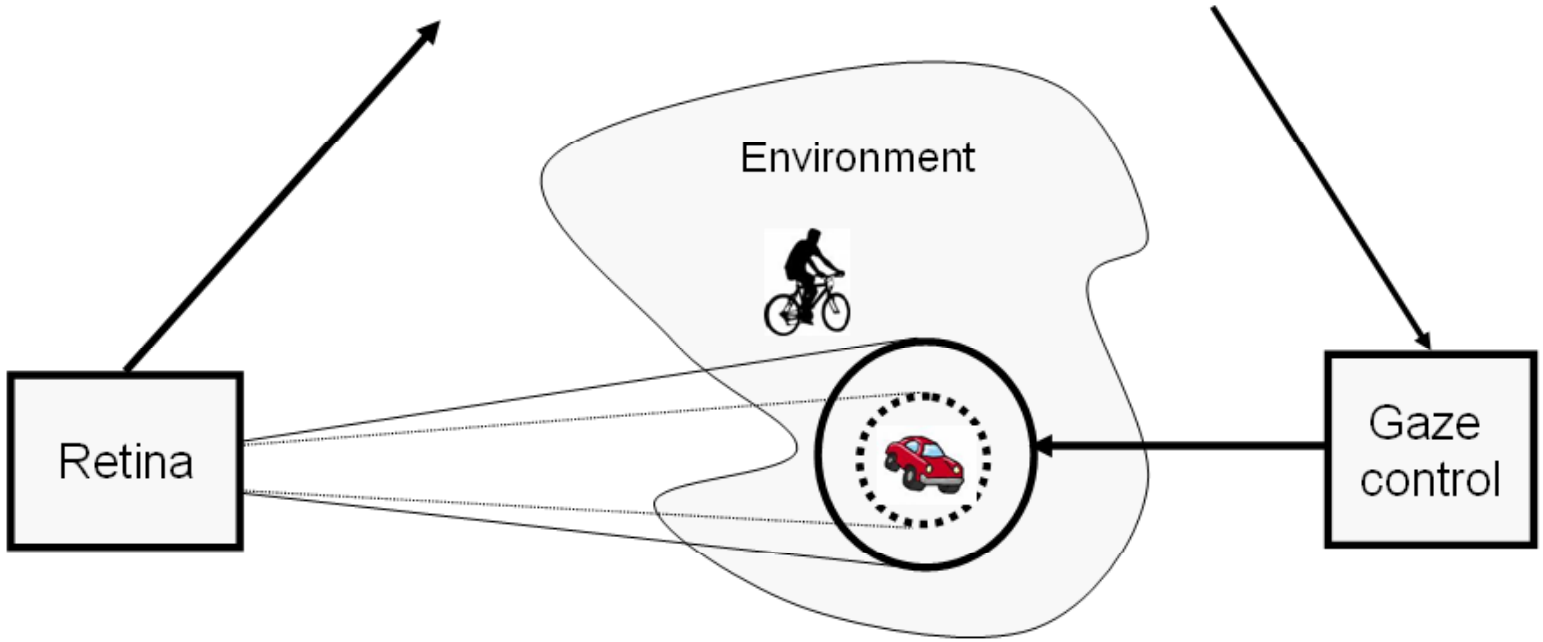
Example: Overriding the stronger ”look-left-for-cars” schema in the T-junction scenario



Three types of task interference

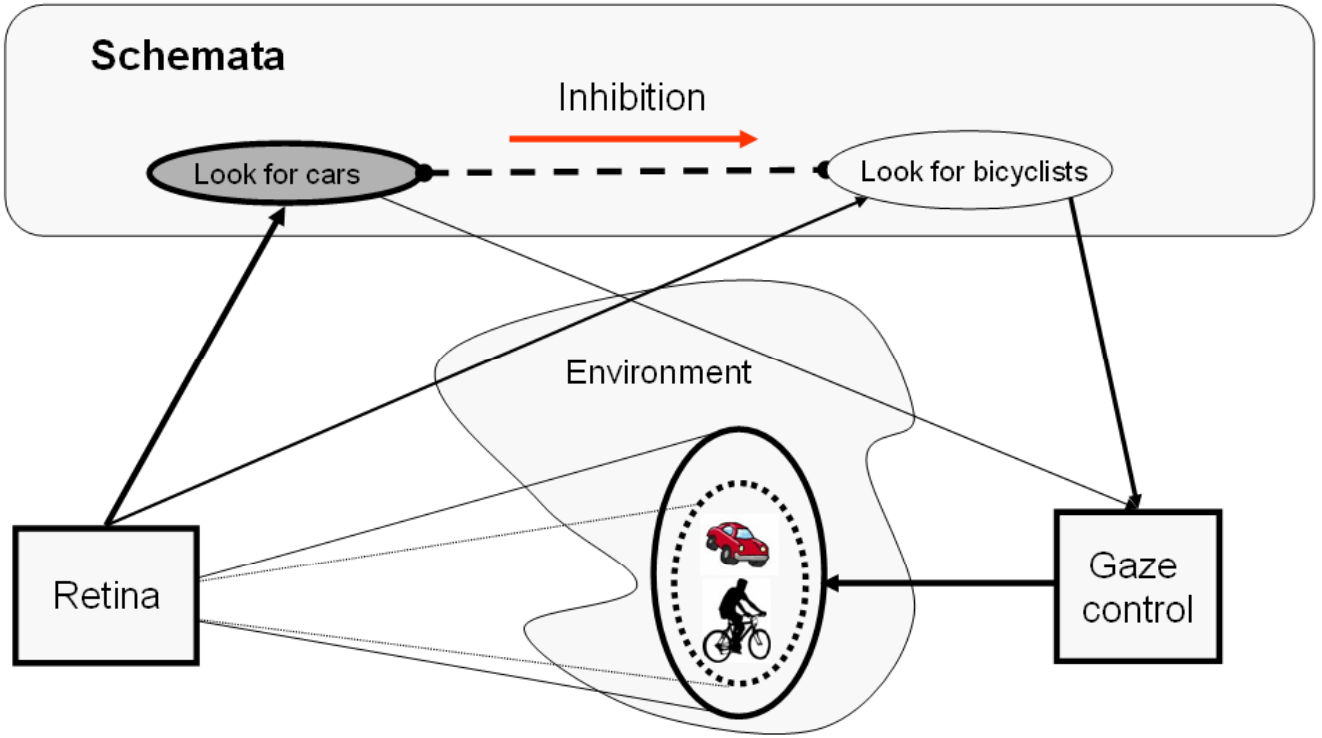
1. Interference in sensory- and/or effector systems

- Physical incompatibility: E.g. “Can’t look at two separated objects at the same time”, “Can’t steer and peel a banana without interference”



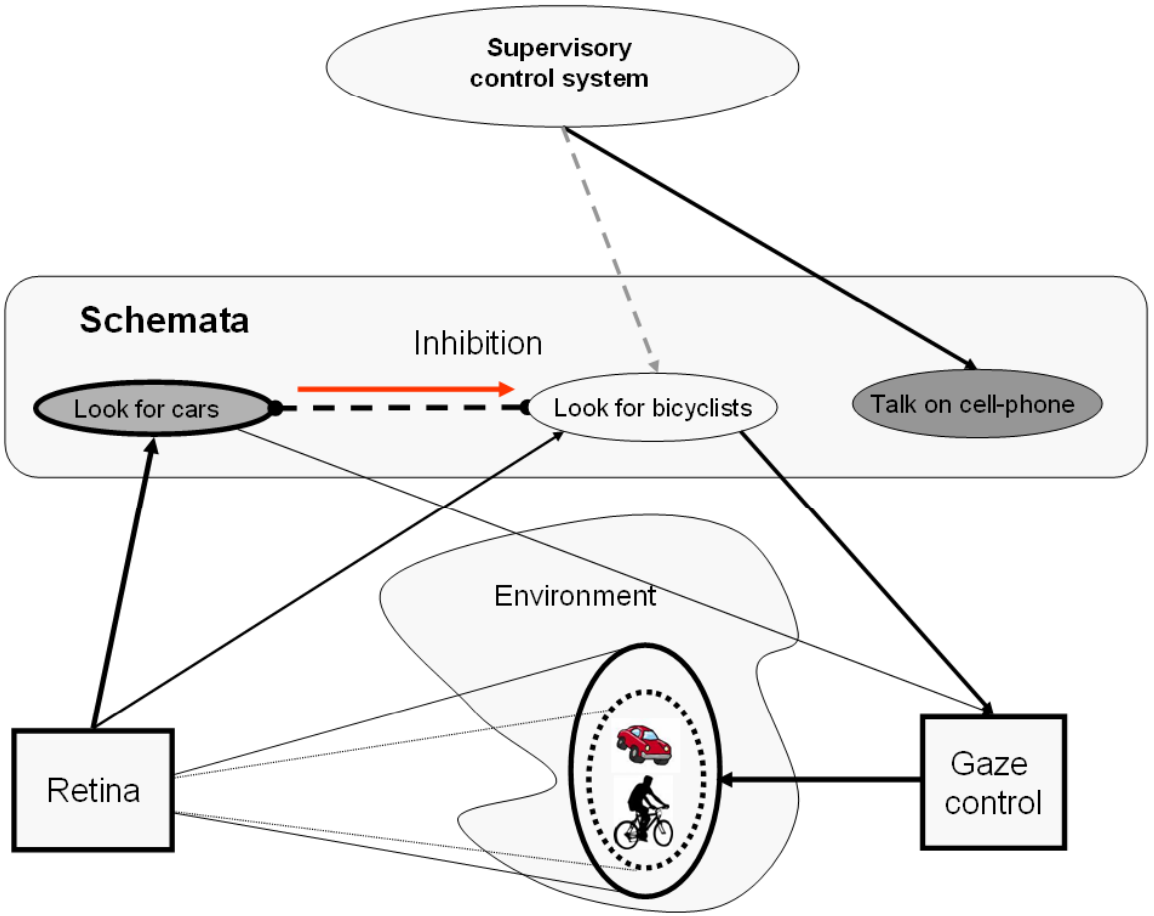
2. Cross-talk interference between schemata

- Inhibition between competing schemata -> **Inattentional blindness, looked-but-failed-to-see**



3. Competition for supervisory top-down bias

- Two independent schemata both require supervisory top-down bias -> **working memory/cognitive load**



Conclusions

- Model intended to capture the active nature of attention selection and accounts for the role of task goals, context and behavioural history
- Enables clear experimental hypotheses regarding the role of expectancy and adaptive, anticipatory scheduling of attention - has been largely ignored in existing empirical work
- Implications for system design
  - Good HMI designs should support the driver's *adaptive and anticipatory task allocation* (not just minimise distraction/workload)
  - A key goal of *driver support systems* should be to support the development of adequate *expectations* (e.g. by means of vehicle-to-vehicle and vehicle-to-infrastructure communication)

Future work

- Test model predictions empirically
  - Behavioural studies
  - Link model activation dynamics to brain imaging…
- Computational modelling…

Thanks for allocating your supervisory top-down bias !!!

Backup

Model predictions (examples)

- Top-down attention selection may be automatic (for routine actions)
- Strong perceptual load (e.g. when negotiating a complex intersection) leads to suppression of attention capture in the same modality
- Working memory load…
  - …affects stimulus detection similarly between modalities
  - …affects detection of predictive stimuli more than unpredictable stimuli
  - …leads to more stereoptyped, inflexible, behaviour (due to lack of supervisory top-down bias
- Most of these predictions confirmed with artificial tasks in laboratory settings but have not been tested in the driving domain