

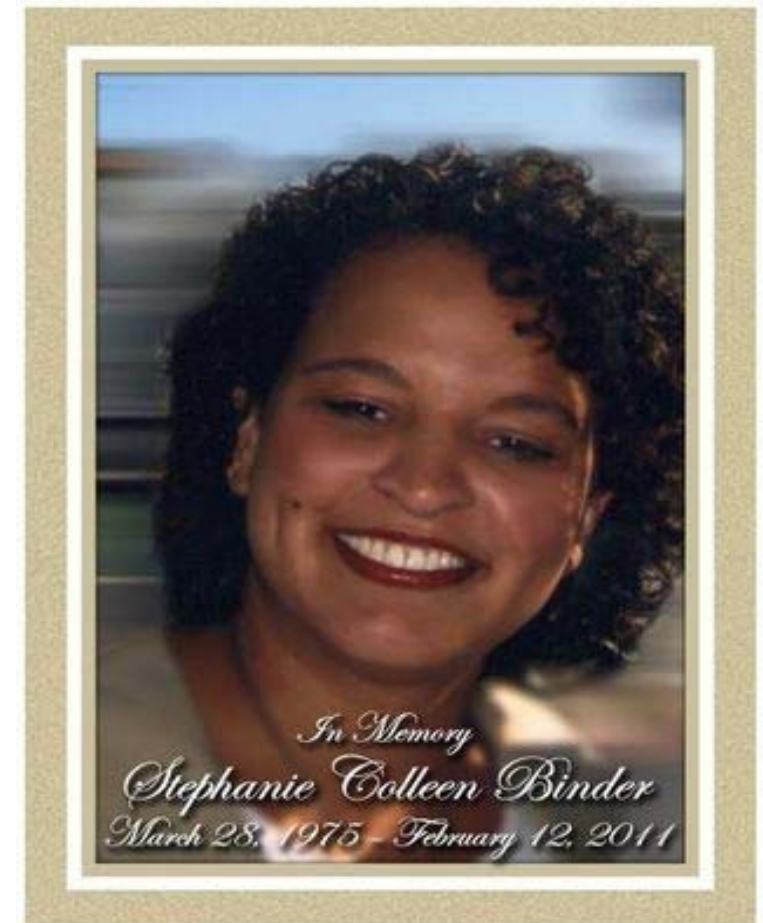


Special Symposium 2:

Stephanie Binder Memorial Lecture

Dr. Johan Engström
Volvo Global Trucks Technology:

"US-EU collaboration towards a common conceptualization and taxonomy of driver inattention"





US-EU collaboration towards a common conceptualization and taxonomy of driver inattention

Johan Engström

**Volvo Group Trucks Technology
Advanced Technology and Research**

**3rd International Conference on Driver Distraction and Inattention
Göteborg, 2013-09-06**

The US-EU Driver Distraction and HMI WG

- Part of the US-EU Bilateral Task Force on ITS
- General objective
 - Identify opportunities for research collaboration, align research and to identify differences
- Members:
 - US: Chris Monk (NHTSA, WG leader), David Yang (FHWA), Dan McGehee (U. Iowa)
 - EU: Johan Engström (Volvo, WG leader), Wolfgang Höfs (EC), Alan Stevens (TRL), Andreas Keinath (BMW),
 - Japan (observers): Saturo Nakajo (MRI)/Aiko Hosaka (Highway Industry Development Organisation)
- ***Main focus so far: Development of a common conceptual basis for driver distraction and inattention***

Many different concepts related to driver distraction and inattention but little agreement on their precise meaning

Attention

Arousal

DROWSINESS

Inattention

Fatigue

Alertness

Cognitive load

Distraction

Vigilance

Mental effort

Mental workload

Looked-but-did-not-see

Inattention blindness

Change blindness

The Focus Group on driver distraction

- Held April 28, 2010 in Berlin
- Aims:
 - Agree on a general definition of driver distraction
 - Define top-10 research needs
- Invited experts:

US Participants			EU Participants	
Richard Hanowski	VTTI		Michael Regan	INRETS
Bill Horrey	Liberty Mutual		Alan Stevens	TRL
John Lee	U. of Wisconsin		Trent Victor	Volvo

Driver distraction is the diversion of attention from activities critical for safe driving to a competing activity.

Report available at

http://ec.europa.eu/information_society/activities/esafety/intlcoop/eu_us/index_en.htm

Several issues left open...

- What are "activities critical for safe driving" – hindsight bias problem
- What is a "competing activity"
- What about diversion of attention to other safety-critical activities (e.g., mirror checks, visual scanning for other vehicles)?
- Does driver distraction necessarily lead to adverse consequences?



- Need for more comprehensive initiative → **The Inattention Taxonomy project**

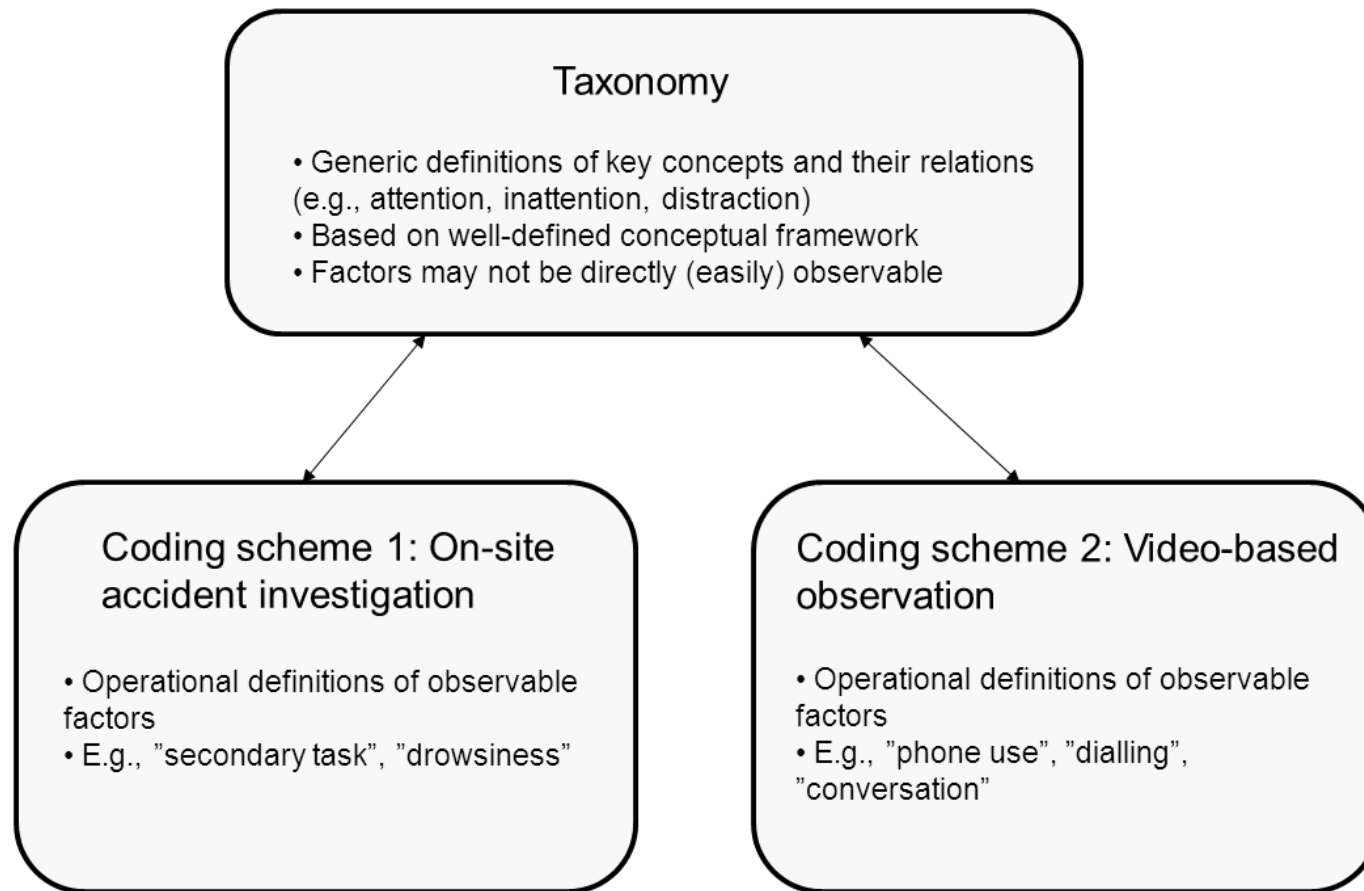
The US-EU inattention taxonomy project

- **Objective:** Define a common taxonomy of driver inattention
- Time frame: June 2011 – May 2013
- Contributors: Johan Engström (Volvo), Chris Monk (NHTSA), Rich Hanowski (Virginia Tech), Bill Horrey (Liberty Mutual), John Lee (University of Wisconsin), Dan McGehee (University of Iowa), Mike Regan (University of New South Wales, Australia), Alan Stevens (TRL), Eric Traube (NHTSA), Marko Tuukkanen (Nokia), Trent Victor (AB Volvo), David Yang (FHWA)

Report (soon) available at

http://ec.europa.eu/information_society/activities/esafety/intlcoop/eu_us/index_en.htm

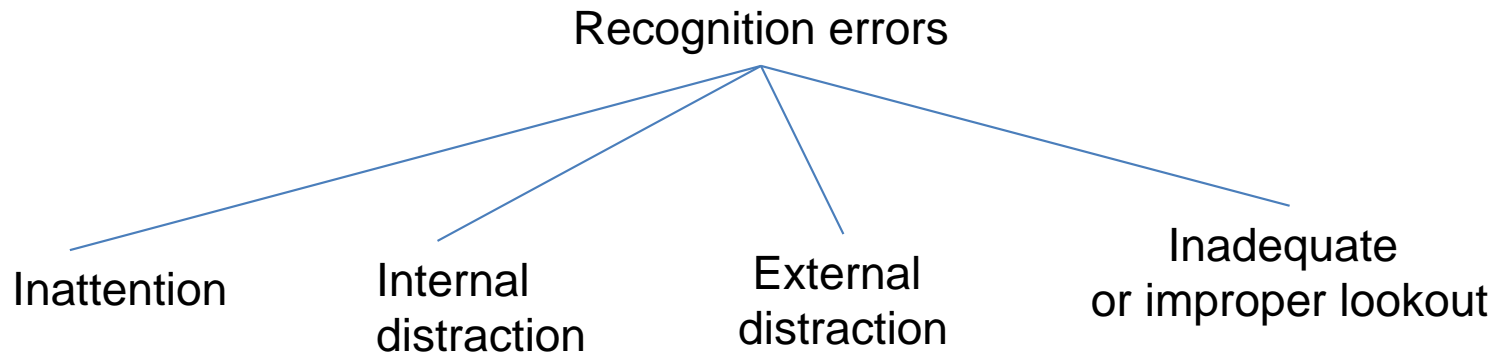
Taxonomy vs. coding scheme



Existing taxonomies of driver inattention (Regan, Hallet and Gordon, 2011)

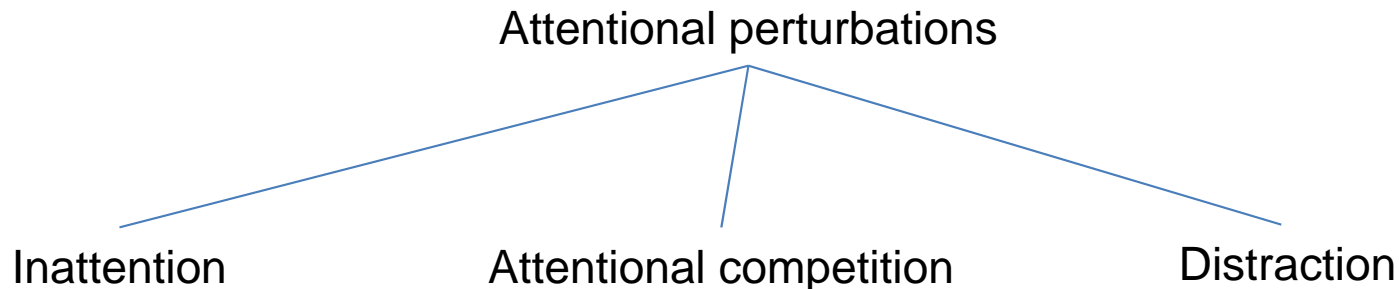
Driver inattention as a sub-category of “attentional failures”

Treat et al. (1980)



Driver inattention=whenever a driver is delayed in the recognition of information needed to safely accomplish the driving task, because of having chosen to direct his attention elsewhere for some non-compelling reason

Hoel, Jaffard and van Elslande (2010)

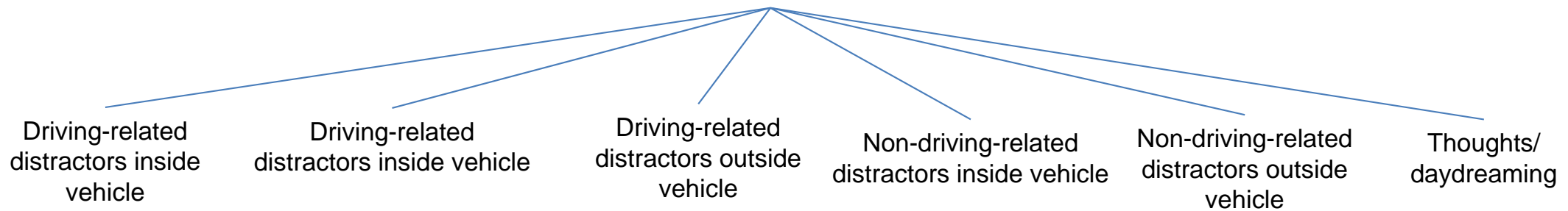


Driver inattention=Interference between a driving activity and “personal concerns” (i.e., internalised thoughts)

Inattention as an umbrella term

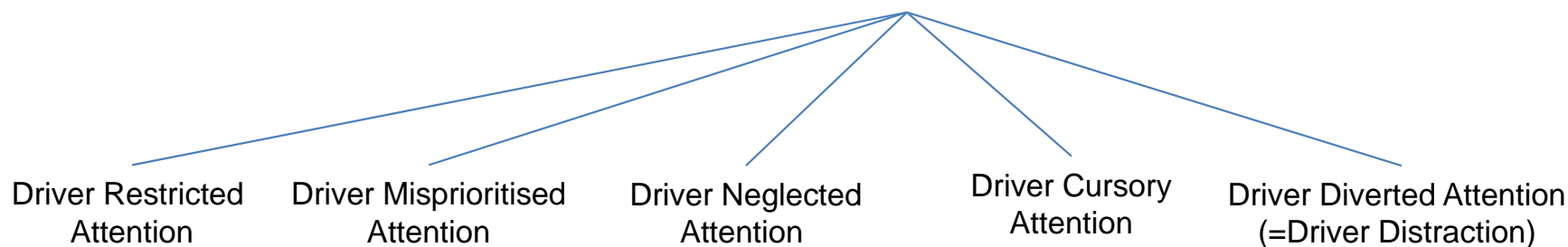
Wallén Warner et al. (2008)

Inattention=any condition, state or event that causes the driver to pay less attention than required for the driving task



Regan, Hallet and Gordon (2011)

Driver inattention=Insufficient, or no attention, to activities critical for safe driving



Other differences between existing inattention taxonomies

- Selection of *information* vs. selection of *activities*
- Inclusion vs. exclusion of fatigue/drowsiness
- Driver distraction vs. diversion of attention to other driving-related/safety critical activities



- **Very little consensus of the concept of driver inattention and related terms such as driver distraction!**

Additional issues

- Hindsight bias not dealt with
- No existing taxonomy offers a clear conceptualization of driver attention



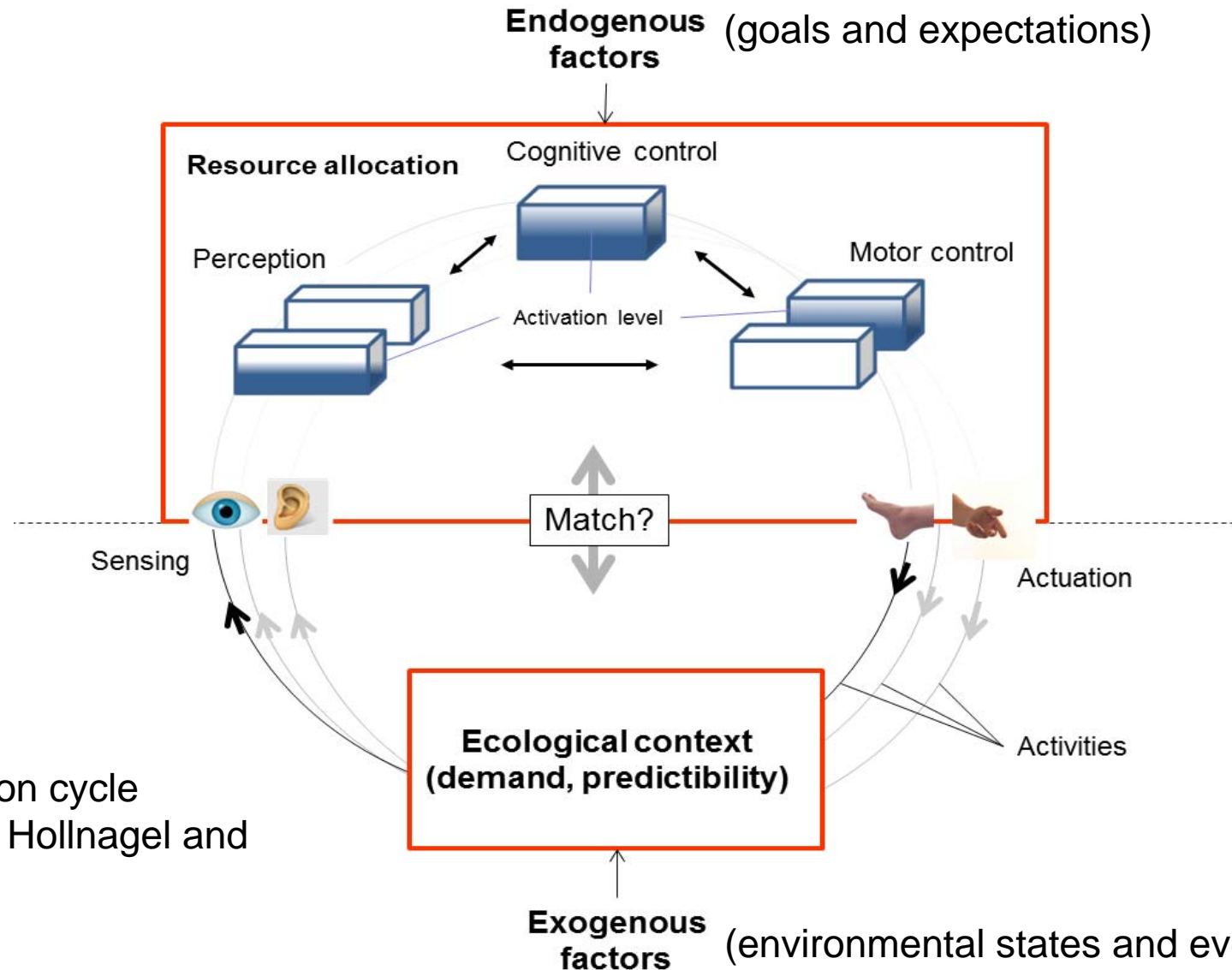
- **First step of present project: Develop a conceptual framework for understanding driver attention**

Driver attention

Driver attention as the allocation of resources to activities

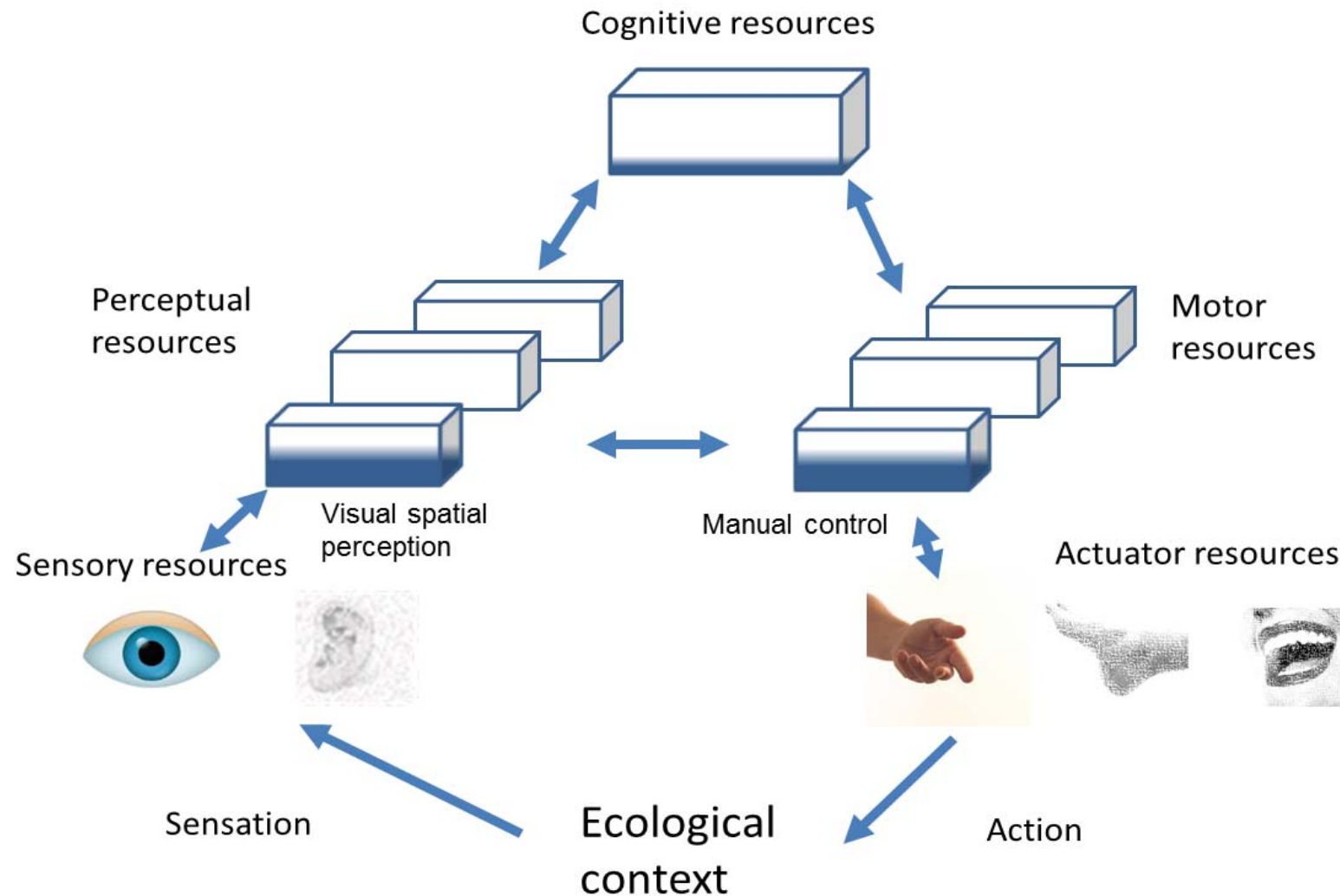
- **Activities:**
 - May involve the selection of information as well as the preparation and execution of actions
 - May or may not extend into the environment (i.e., includes purely mental activities)
 - Task=goal-directed activity
- **Resources:** Any sensory, actuator, perceptual, motor or cognitive mechanism that is utilised in performing activities
- **Driver attention:** The allocation of resources to activities
- **Attentional state:** The current allocation of resources over activities

Driver attention allocation as situated in an ecological context and driven endogenously as well as exogenously

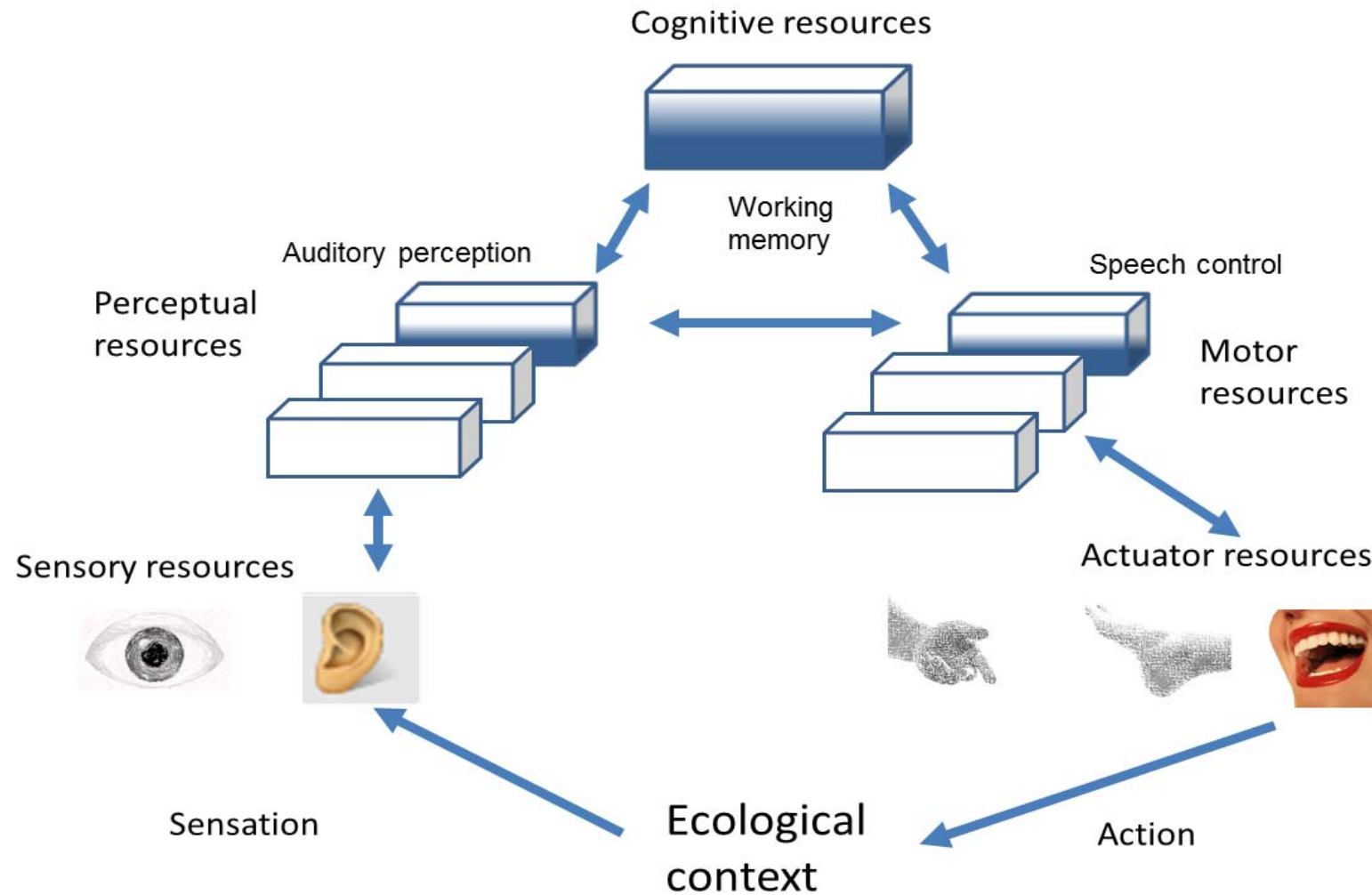


Perception-action cycle
(Neisser, 1976; Hollnagel and
Woods, 2005)

Example: Lane keeping (in easy conditions)

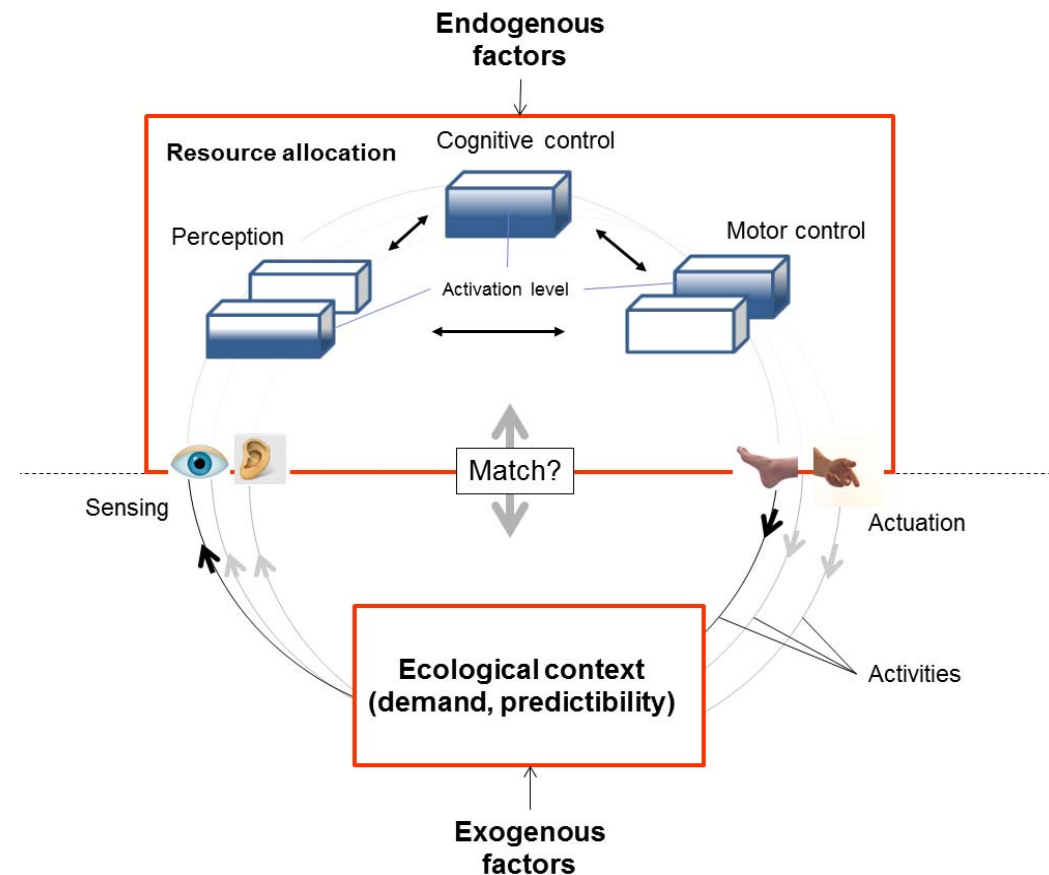


Example: Hands-free phone conversation



Main dimensions: Attentional activation vs. selectivity

- **Activation:** The degree to which resources are allocated to activities
 - Determined by task demand, attentional effort, alertness etc.
- **Selectivity:** How resources are distributed between activities
 - Multiple activities with competing resource demands -> the driver has to prioritise certain activities above other activities



Driver inattention

Inattention: The layperson's view

- *Inattention*: “failure to pay attention or take notice” (Shorter Oxford English Dictionary on Historical Principles, 2002, p. 1340).
- Inattention is a failure to attend to *something* that one “should” attend to
- “In driving, the driver should attend to driving and. If he fails to do so, he is inattentive”
- Normative and depends on subjective judgement of what is important to attend to in a particular situation

What is the more important?



Example from Peter Hancock

Is the driver inattentive?



Was the driver inattentive?

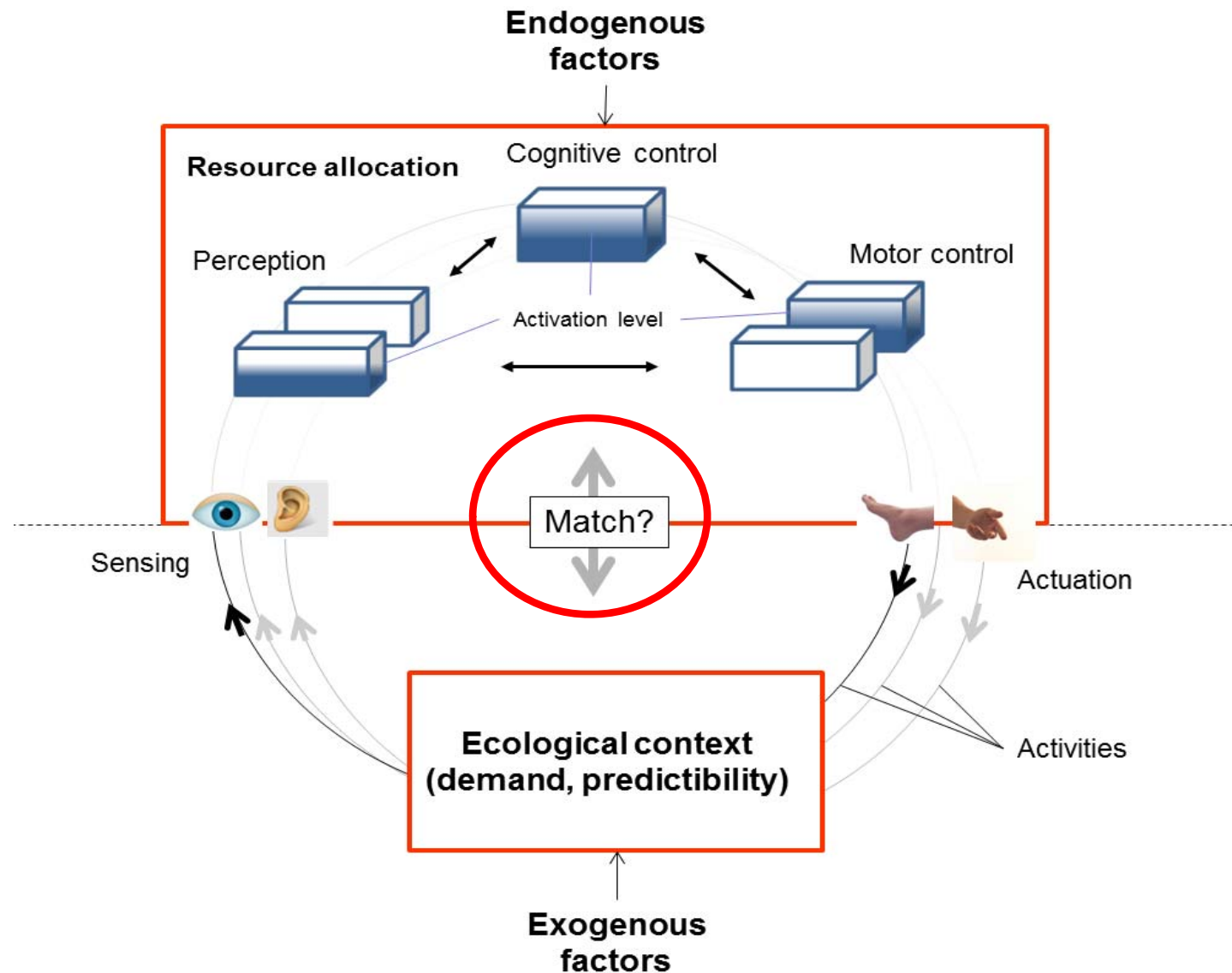


On February 7, 2008, a small DA40 Diamond Star had to perform an emergency landing on Riksväg 45 just outside of Gothenburg, Sweden. The landing gear hit the roof a car that was driving on the road. No one was critically injured.

Problems with the layperson view (from a scientific viewpoint)

- Driving consists of a variety of sub-tasks - may not be possible to attend to all at the same time.
- Determining which sub-task that is most important (and the driver thus should attend to) can often only be determined after the fact (i.e., after a crash or incident occurred) - *hindsight bias*
- Even “perfect” attention allocation may sometimes “fail”, e.g., due to improbable events (“bad luck”) (Moray, 2003)
- Defining inattention in terms of a failure of the driver implies the assignment of *blame* - often not relevant for the understanding of crash causation

The systemic view: Inattention as a mismatch



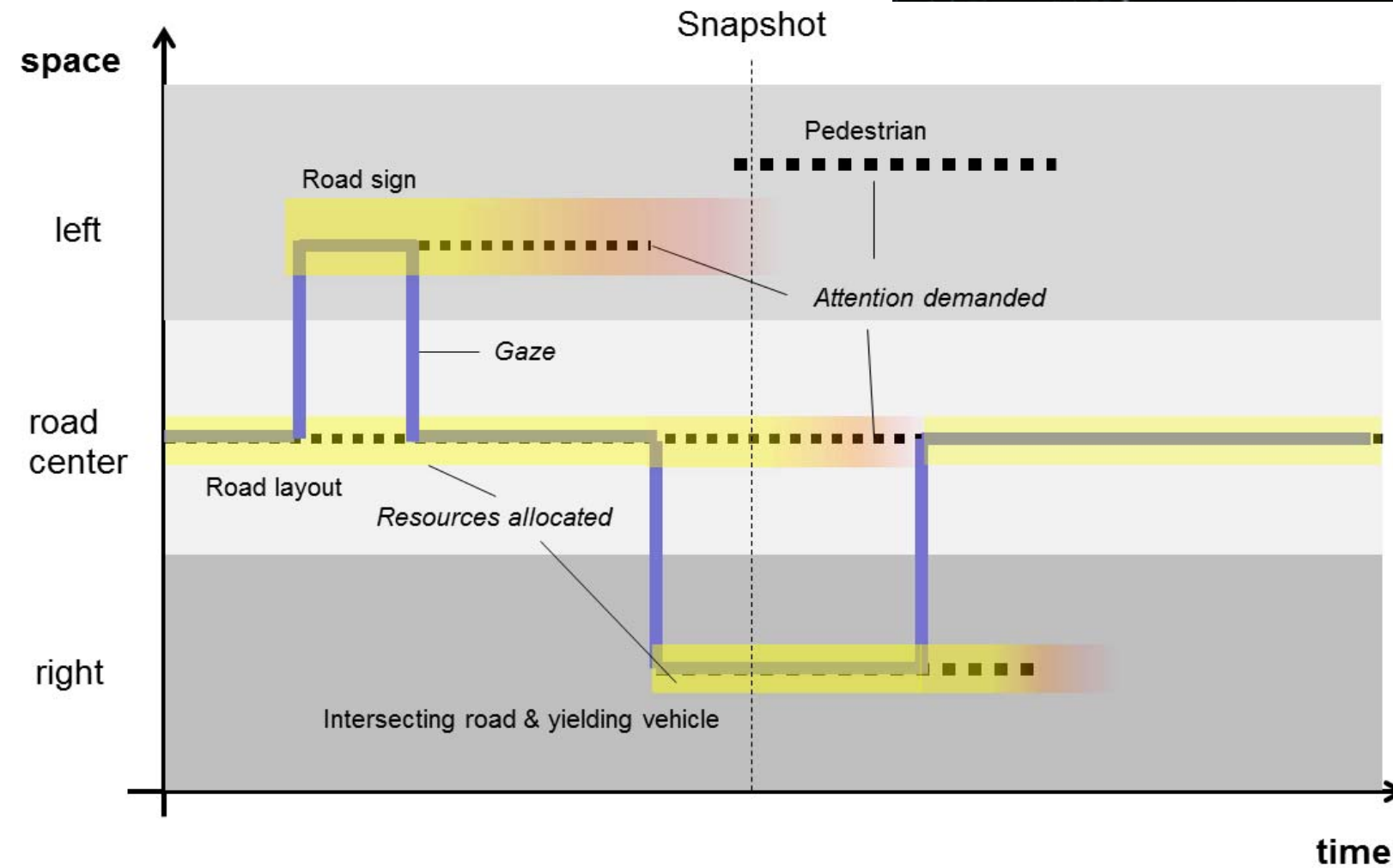
Defining driver inattention

- *Inattention=mismatch* between the current allocation of resources and those resources demanded by activities critical for safe driving
- *Activities critical for safe driving* = activities required for the control of *safety margins*
 - *Includes*: Maintaining headway, keeping in the lane, visually scanning an intersection for oncoming vehicles, deciding whether to yield and interpreting safety-related traffic signs,
 - *Excludes*, e.g., navigation, route finding and eco-driving + all non-driving activities

Illustration of attentional mismatch



Timing matters

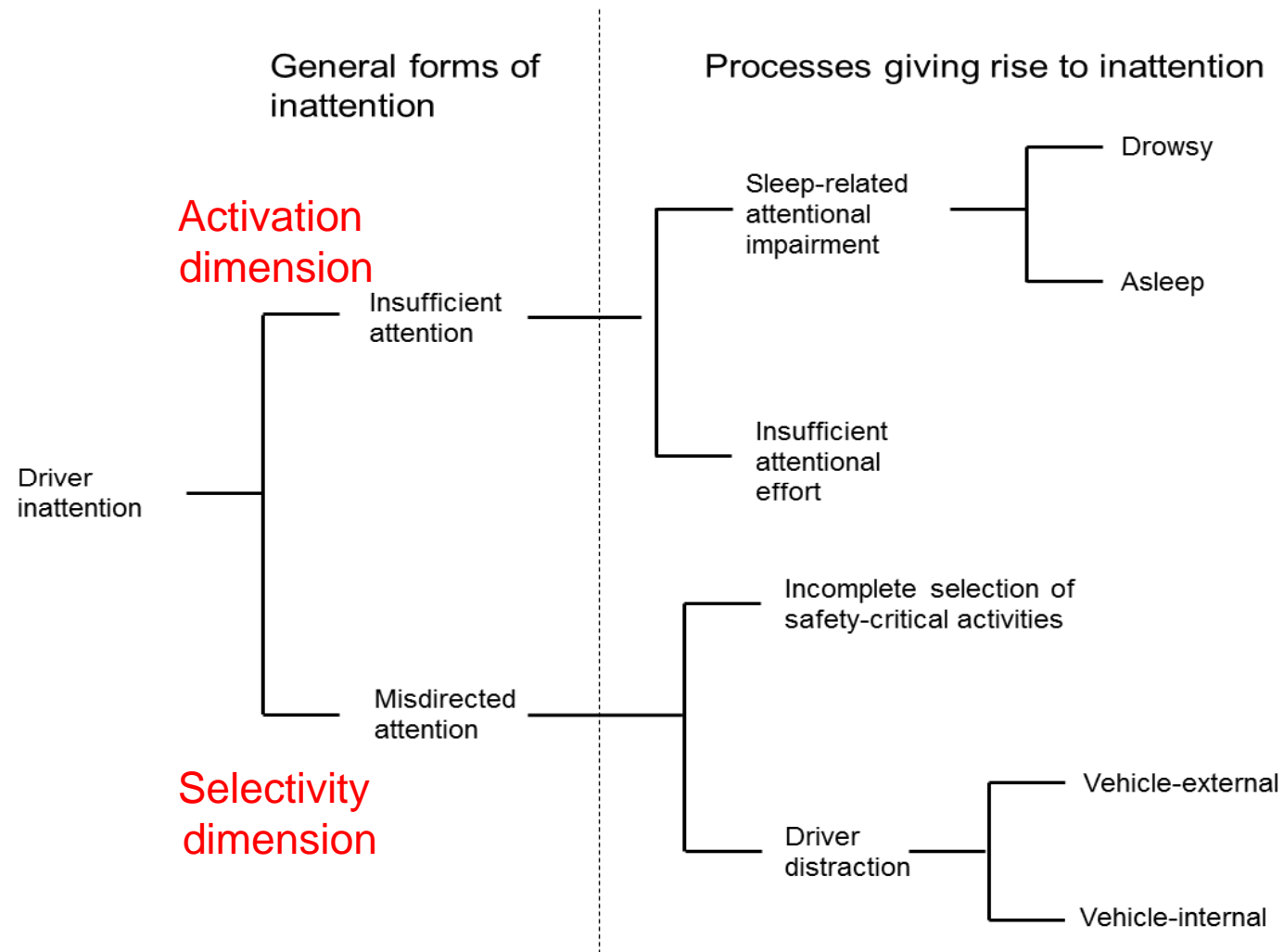


Some implications

- Driver inattention represents a failure (or discrepancy) in the driver-vehicle-environment system as a whole, not a failure/error of the driver
- The concept of driver inattention is logically independent of the event outcome – inattention does not have to lead to adverse consequences
- Hindsight bias is reduced (but perhaps not avoided in practice)

Inattention taxonomy

Proposed taxonomy

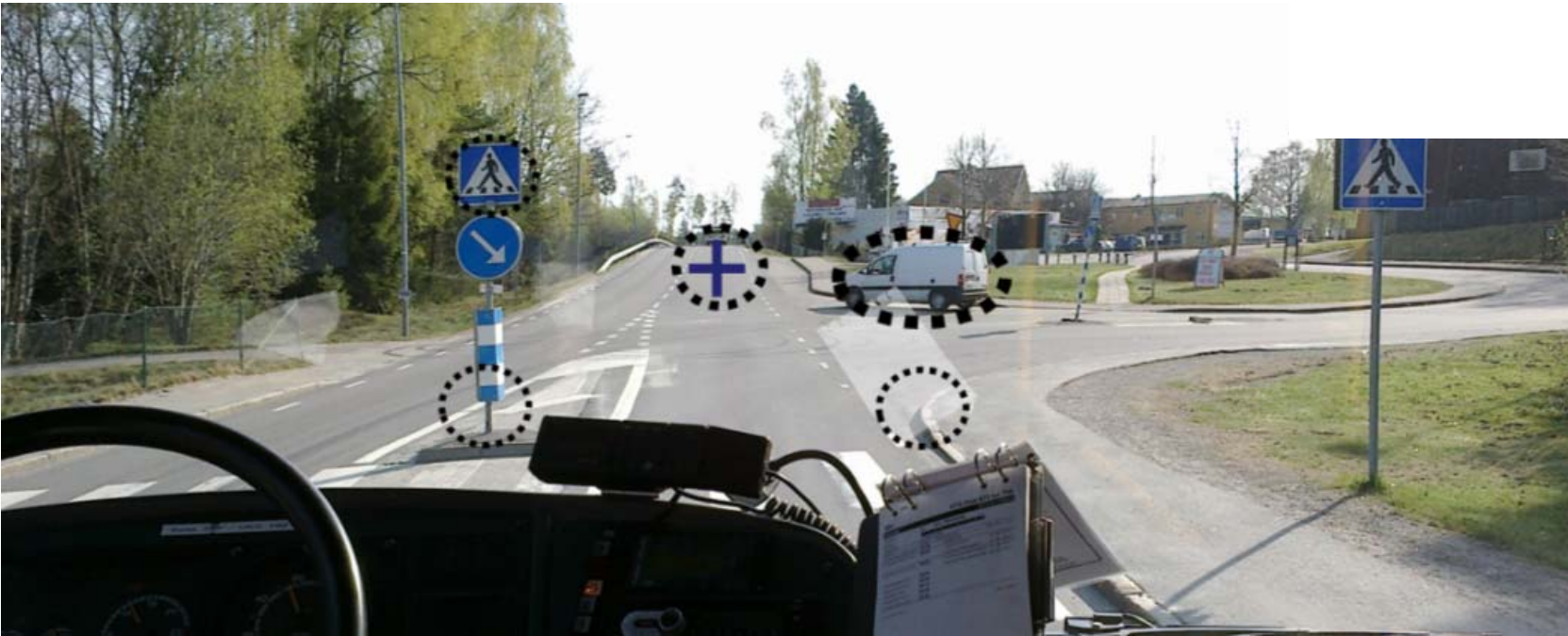
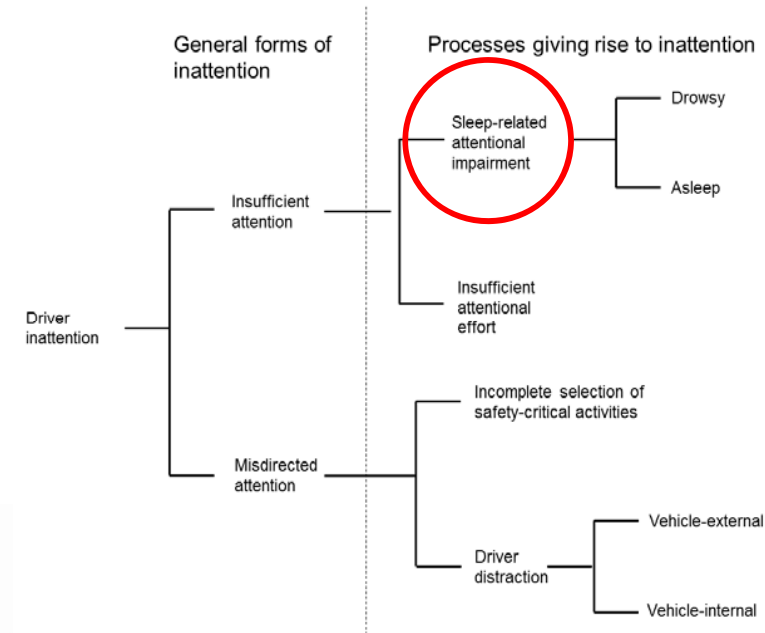


Insufficient vs. misdirected attention

- **Insufficient attention:** When the degree to which resources are allocated fails to match that demanded by activities critical for safe driving.
- **Misdirected attention:** When the demands of activities currently critical for safe driving are not matched due to the allocation of resources to other safety-critical or non-critical activities.

Insufficient attention/sleep-related impairment

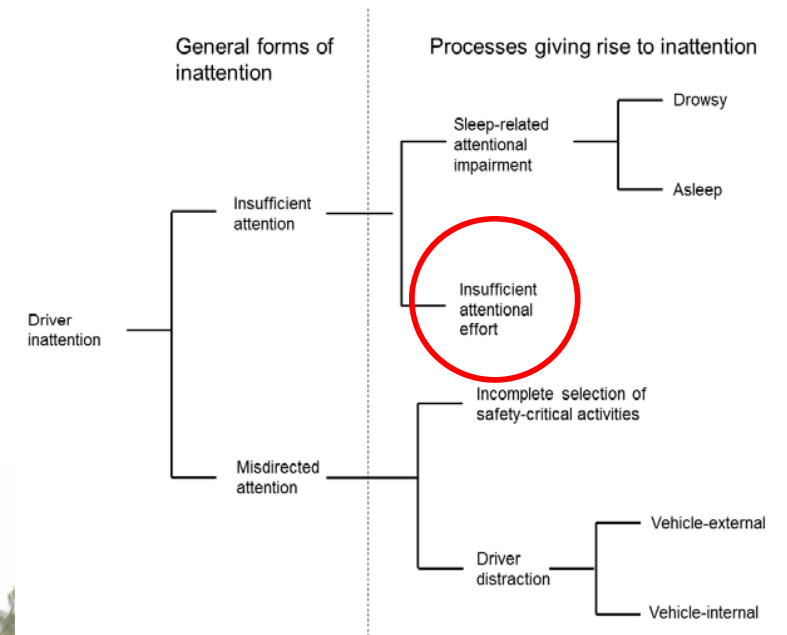
The driver's allocation of resources to activities critical for safe driving does not match the demand of these activities due to factors related to sleep regulation



Example: Driver asleep and does not allocate any resources to driving

Insufficient attention/insufficient attentional effort

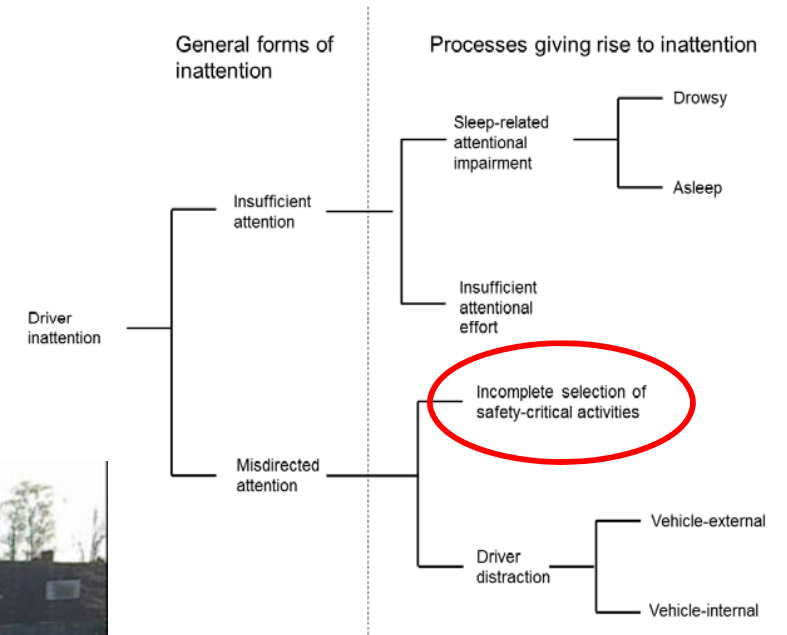
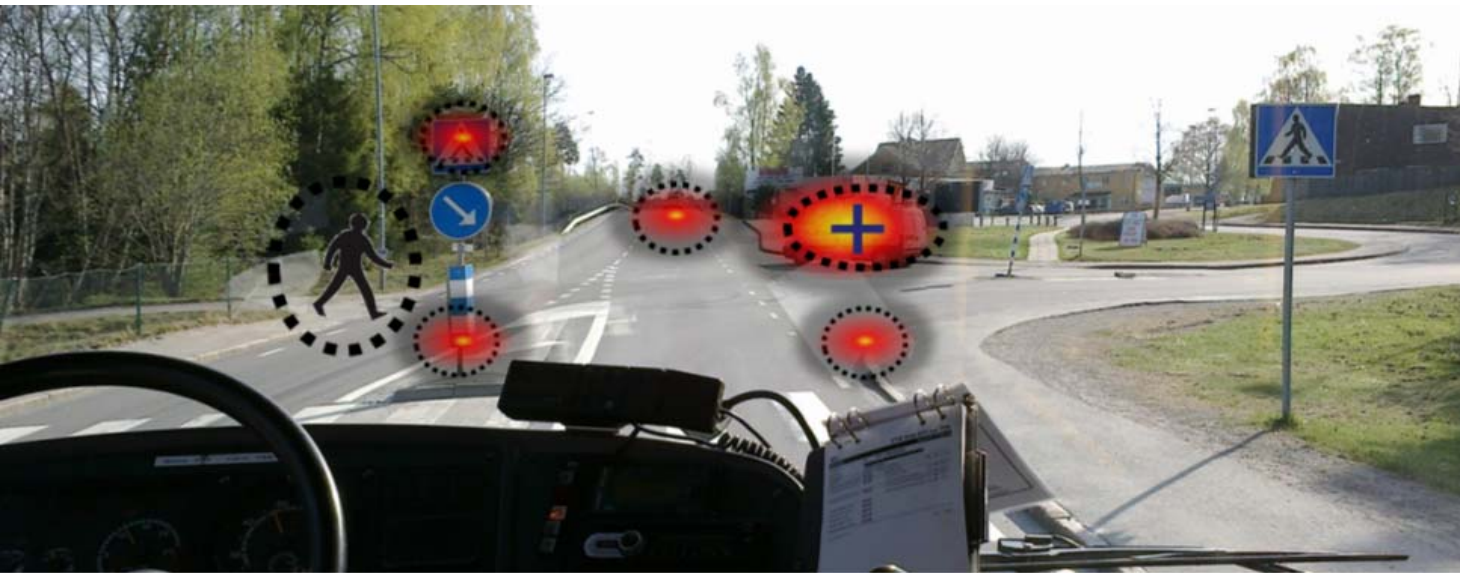
The driver's allocation of resources to activities critical for safe driving does not match the demand of these activities due to an inability of the driver to mobilise sufficient attentional effort



Example: The driver allocates some resources to activities critical for safe driving but the amount of resources allocated is insufficient to match the attentional demands of those activities.

Misdirected attention/incomplete selection of safety-critical activity

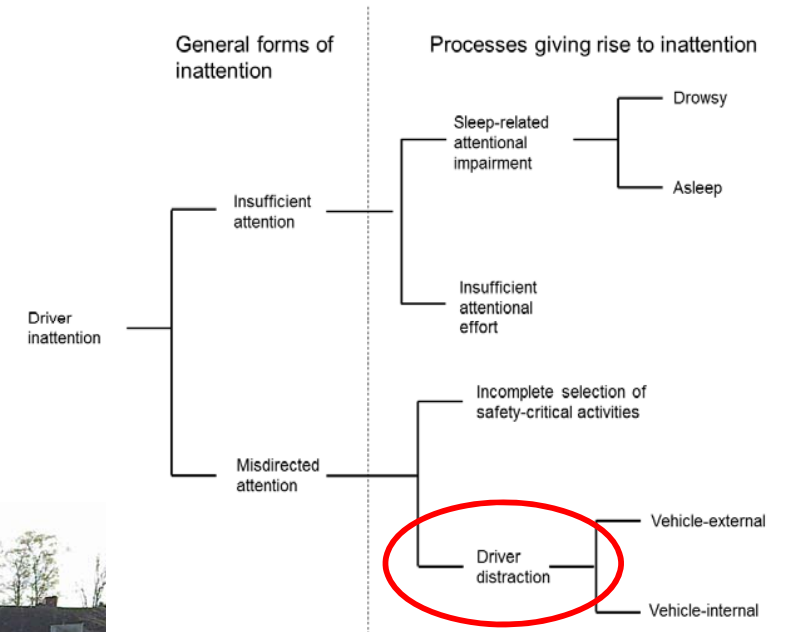
The driver allocates sufficient resources to one or more activities critical for safe driving, or believed by the driver to be critical for safe driving, while the resources allocated to other activities critical for safe driving do not match the demands of these activities



Example: The driver generally allocates sufficient resources to locations expected to be relevant for safe driving but fails to account for the pedestrian appearing on the left.

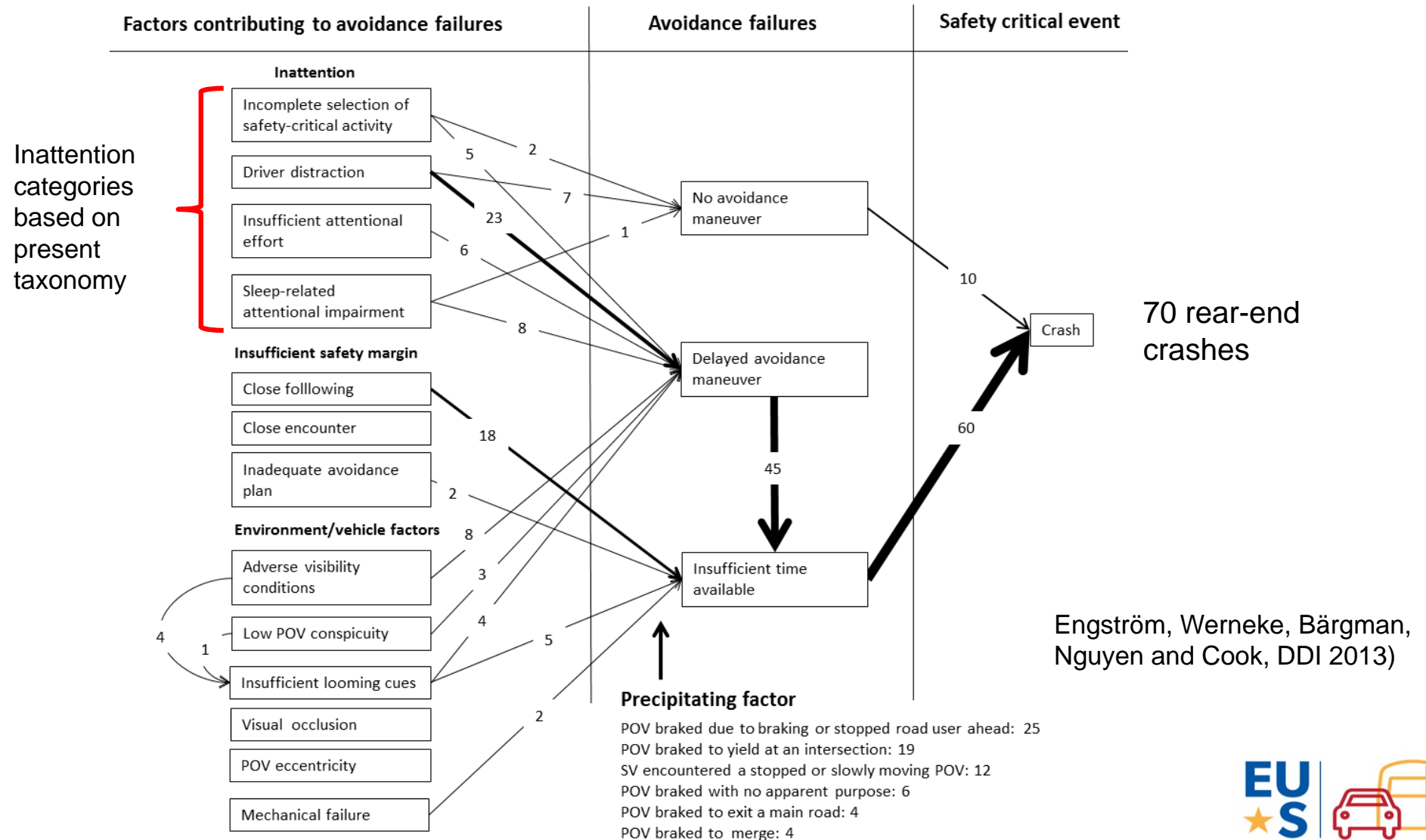
Misdirected attention/driver distraction

The driver allocates resources to a non-safety critical activity while the resources allocated to activities critical for safe driving do not match the demands of these activities



Example: The driver allocates sufficient resources to interacting with an in-vehicle display (vehicle-internal distraction) while the resources allocated to the road do not match those demanded

Application: Analysis of crash-contributing factors in naturalistic driving (DriveCam) crash data



Engström, Werneke, Bärgrman, Nguyen and Cook, DDI 2013)

Conclusions

- Current effort first step towards a more harmonised conceptualisation of inattention and related terms
- Will be put to test when used in practical applications
- Should be relatively stable in the face of technological and scientific advances, but future revision may still be needed
- Future versions of the taxonomy may include more fine-grained categories
- A main issue is the discrepancy between the present scientific, blame-neutral, view of inattention and the common use of the term – perhaps use more technical term (e.g., “attentional mismatch”)

Thank you for allocating your sensory, actuator, perceptual, motor and cognitive resources to this lecture, thus avoiding mismatches between your allocation of resources and those demanded by activities critical to understand what I was talking about!

Extra slides

Resource categories

- **Sensory resources:** Sense organs such as the eyes or the ears while
- **Actuator resources:** Actuators such as the hands or the feet
- **Perceptual resources:** Neural mechanisms underlying detection and interpretation of information
- **Motor resources:** Neural mechanisms that control overt action.
- **Cognitive resources:** Neural mechanisms underlying working memory and the effortful deployment of resources to deal with non-routine tasks (cognitive control)

Systemic, third-person view

- Mismatch between the driver's current allocation of attention and that demanded by activities critical for safe driving
- Independent of whether we think that the driver *should have* attended to the plane - > legal (normative issue)
- Still, the discrepancy with the layperson's understanding of "inattention" is problematic



Driver's
attentional focus