

Driver Distraction: Some Reflections on a Path to Understanding



Michael A. Regan, PhD
Chief Scientist-Human
Factors
Australian Road
Research Board

Adjunct Professor
University of NSW,
Australia

Trusted advisor on roads and transport

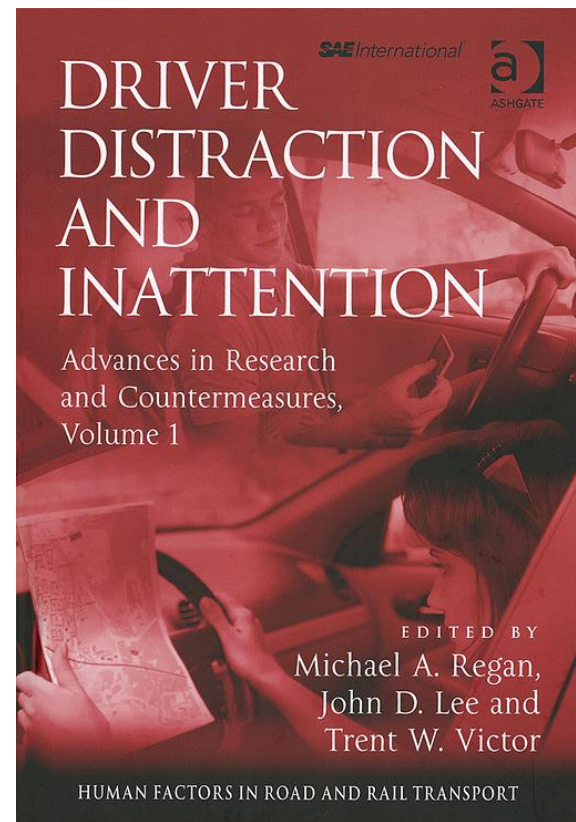
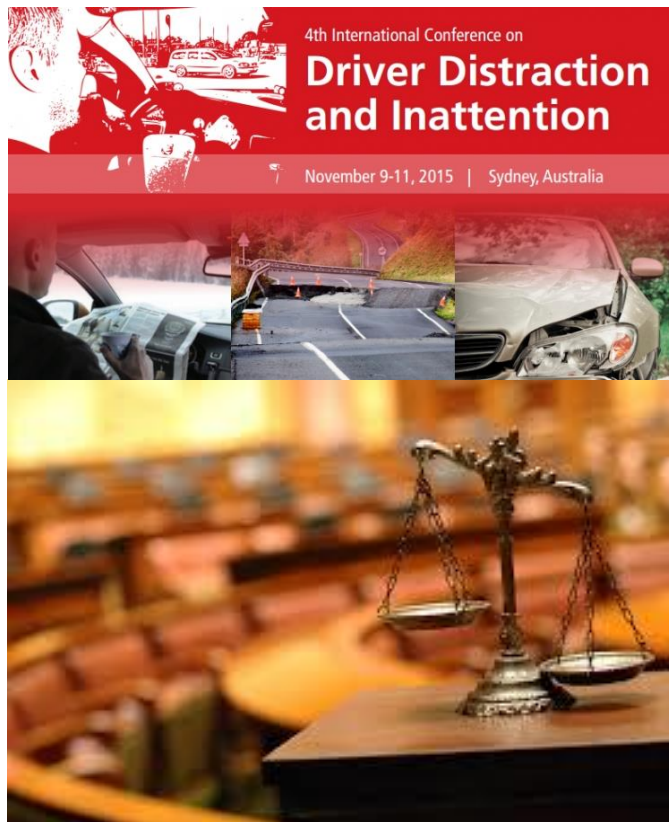
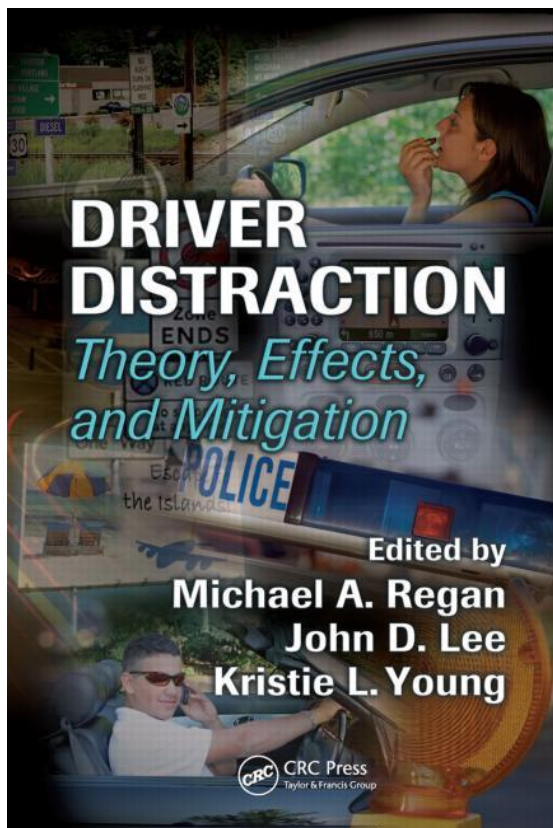


Overview

- An uncertain journey



The Path to Understanding ?



The Same Thing?



Driver Distraction?

Distracted driving?



Driving



- route finding
- route following
- velocity control
- collision avoidance
- rule compliance
- vehicle monitoring

(Brown, 1986)

Definitions of Distraction – Key Elements



- Diversion of attention away from driving activities
- Attention diverted toward a competing activity, inside or outside the vehicle
- Competing activity may or may not be driving-related
- Diversion of attention may be voluntary or involuntary
- Implicit, or explicit, assumption that safe driving is adversely effected

Inconsistency in Definitions



- can make comparison of research findings across scientific studies difficult or impossible; are we measuring the same thing?
- different definitions can lead to different classification schemes for coding crash data; eg do we code distraction if a lost driver was looking for a street sign and crashed?
- can result in different estimates of the role of driver distraction in crashes and critical incidents

So What's Distraction?



- Police pursuit
- Being asleep or drowsy
- Sudden illness
- Chronic illness

What do the Experts Think?.....

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

(Engström et al., 2010, USA-EU Expert Focus Group on Driver Distraction)

- *“...where 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.”*

(Engström et al., 2013, US-EU ITS Cooperation, Driver Distraction and HMI Working Group)

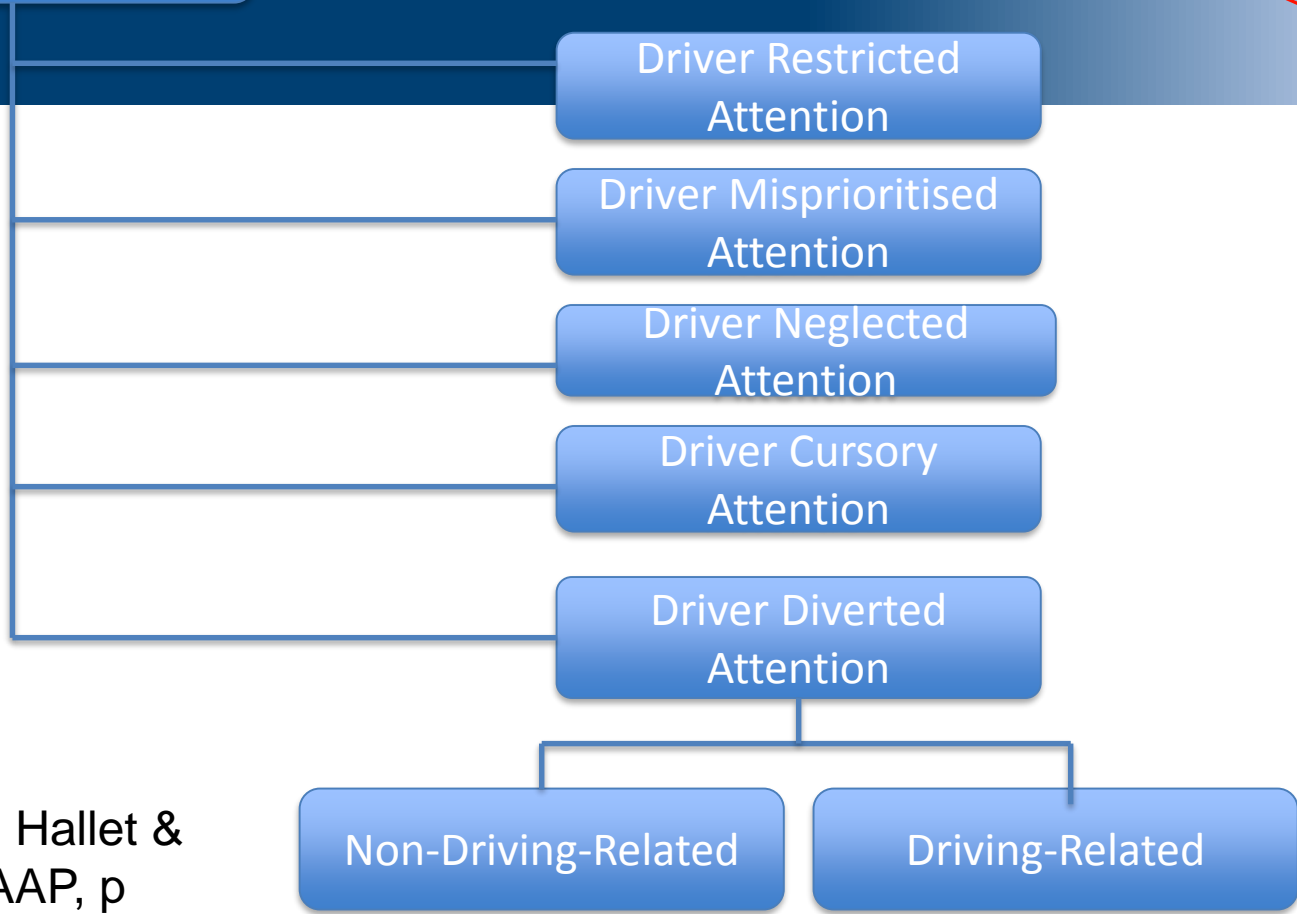
Distracton and Inattention



To be able to define, characterise and measure distraction, it is important to be able to differentiate it, theoretically, and operationally, from other mechanisms of inattention

Driver Inattention

A Taxonomy of Driver Inattention

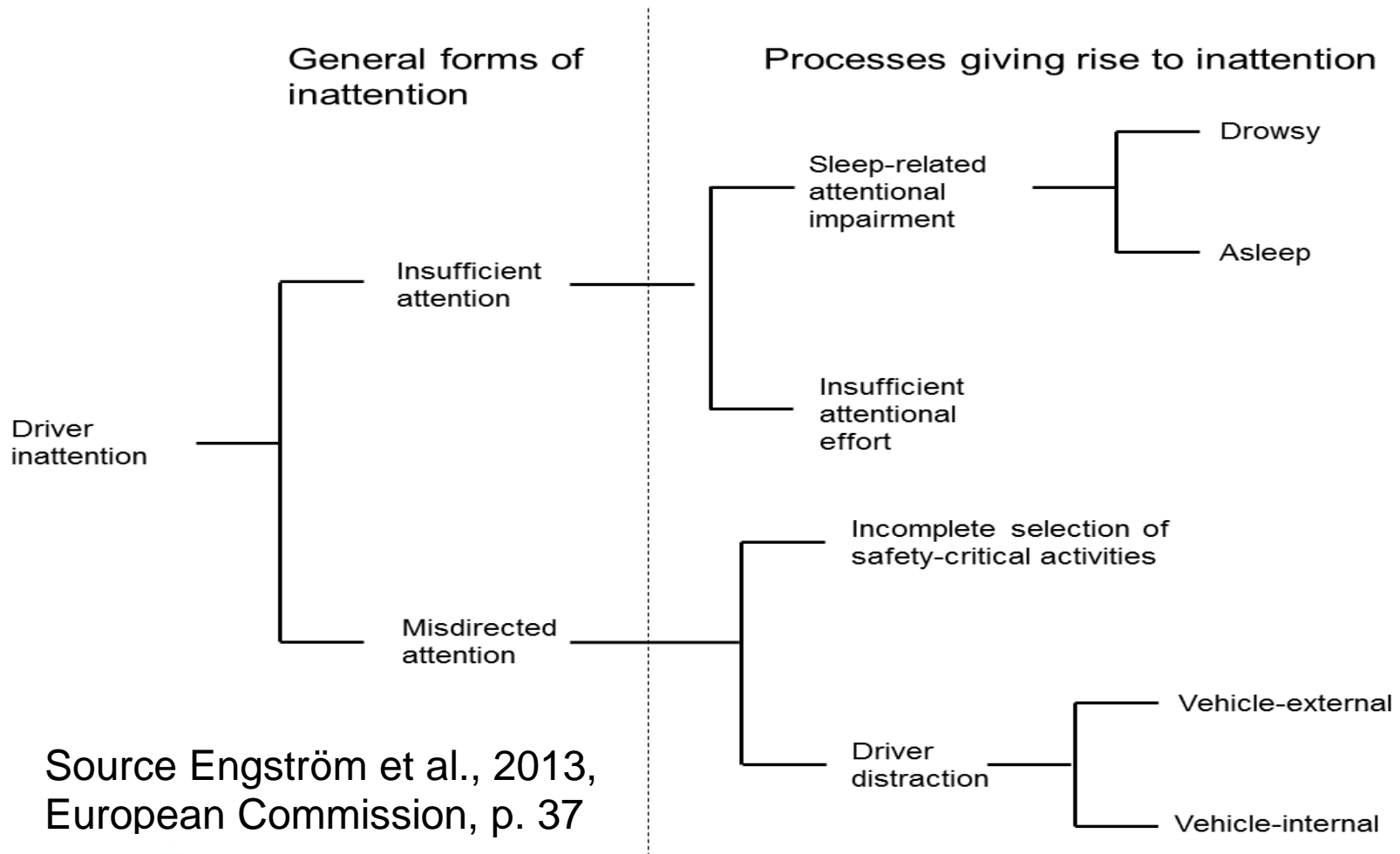


Source: Regan, Hallet & Gordon, 2011, AAP, p 1774

Internal competing activities

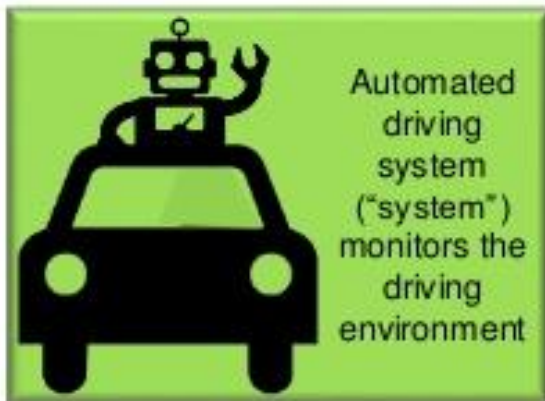
- | | |
|--|---|
| <ul style="list-style-type: none">• Task-unrelated thoughts:<ul style="list-style-type: none">○ Internal/Intentional○ Internal/ Unintentional○ External/Intentional○ External/Unintentional• Daydreams | <ul style="list-style-type: none">• Task-related thoughts |
|--|---|

Another Taxonomy of Driver Inattention



Source Engström et al., 2013,
European Commission, p. 37

SAE J3016 (Jan 2014) Driving Automation Definitions



SAE level	Name	Execution of Steering and Acceleration/Deceleration	Monitoring of Driving Environment	Fallback Performance of Dynamic Driving Task	System Capability (Driving Modes)
-----------	------	---	-----------------------------------	--	-----------------------------------

0	No Automation	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	System	Human driver	Human driver	Some driving modes

3	Conditional Automation	System	System	Human driver	Some driving modes
4	High Automation	System	System	System	Some driving modes
5	Full Automation	System	System	System	All driving modes

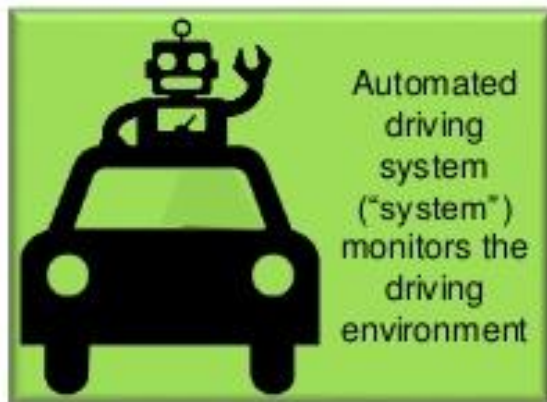
Definition of Driver Distraction (Level 3)

- For a Level 3 automated vehicle, when the vehicle is in control, “driver distraction” takes on a new meaning.
- We might define it, more specifically, as:
- *“the diversion of attention, away from monitoring the state of vehicle automation, toward a competing activity”*.

MADE UP ON THE RUN ON THE
LAWNS OF MIT BOSTON ...



SAE J3016 (Jan 2014) Driving Automation Definitions



SAE level	Name	Execution of Steering and Acceleration/Deceleration	Monitoring of Driving Environment	Fallback Performance of Dynamic Driving Task	System Capability (Driving Modes)
-----------	------	---	-----------------------------------	--	-----------------------------------

0	No Automation	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	System	Human driver	Human driver	Some driving modes

3	Conditional Automation	System	System	Human driver	Some driving modes
4	High Automation	System	System	System	Some driving modes
5	Full Automation	System	System	System	All driving modes

Distraction and Automated Vehicles (Level 3)

- Periods of automated driving may encourage driver involvement in distracting activities that are more stimulating, to the detriment of monitoring the environment or state of vehicle automation (eg Merat et al., 2012; Carsten et al., 2012)
- Driver distraction may impair a driver's ability to safely take back manual control of the vehicle if required and to re-engage. (eg Zeeb et al)
- Driver distraction may reduce situational awareness, leading to automation surprises (Hollnagel & Woods, 2005) or mode confusion (Cummings and Ryan, 2014)



Distraction and Automated Vehicles (Level 3)...

- Periods of automated driving may reduce distraction by freeing up attention for the performance of distracting driving-related tasks (e.g. route finding) that are not automated in the vehicle
- Young drivers will be more distracted in autonomous vehicles than older drivers
- The amount and type of distraction will differ between Levels 1 to 3 of the SAE taxonomy

Distraction and Automated Vehicles (Levels 4 and 5)

- drivers of non-autonomous vehicles might be distracted by the behaviour of fully autonomous vehicles that violate their expectations
- is it possible for the vehicle itself to be distracted? “Vehicle distraction”?
- drivers themselves may in future become sources of “vehicle distraction”.



Vehicle Distraction – A Definition

- *“Vehicle distraction is the diversion of vehicle attention away from activities critical for safe driving, toward a competing activity”.*



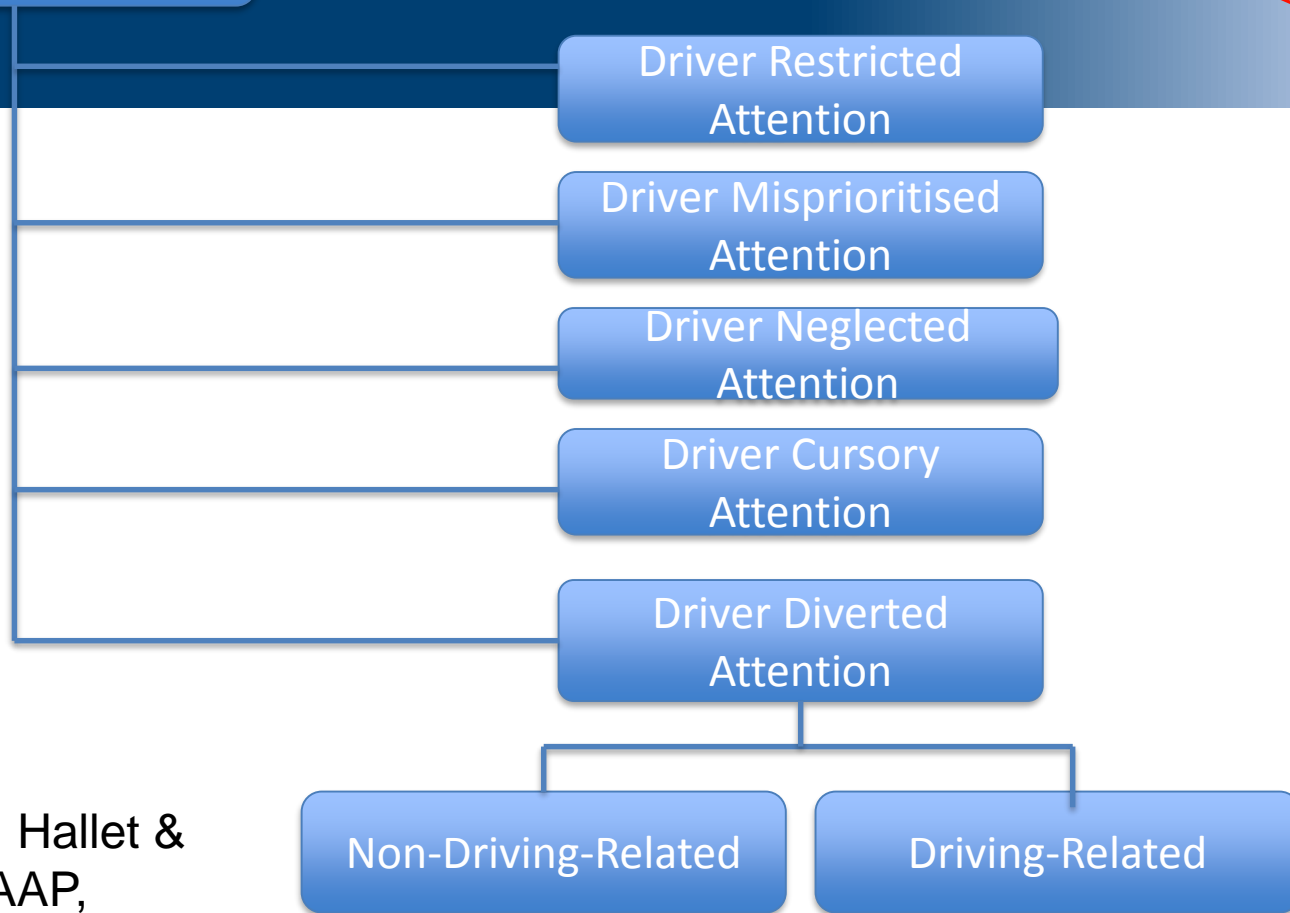
The Inattentive Vehicle

- For a vehicle to be attentive to activities critical for safe driving, its algorithms will need to be programmed such the vehicle knows, from moment to moment, what activities critical for safe driving it should attend to.
- Not a trivial task....
- Via what mechanisms might a self-driving car might become inattentive to activities critical for safe driving?



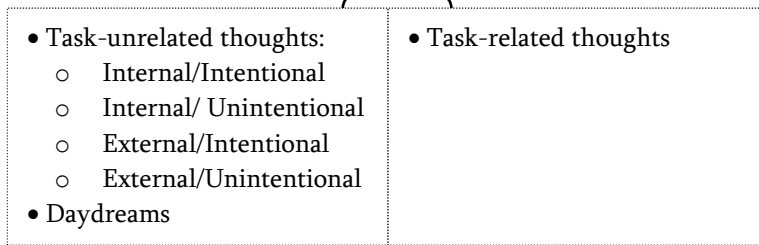
Driver Inattention

A Taxonomy of Driver Inattention



Source: Regan, Hallet & Gordon, 2011, AAP, p1774

Internal competing activities



'4 Types of Distraction'

“...there are four basic types of distraction: visual distraction (e.g. looking away from the roadway), auditory distraction (e.g. responding to a ringing cell phone), biomechanical distraction (e.g. manually adjusting the radio volume), and cognitive distraction (e.g. being lost in thought).”

(ERSO, EU, 2015, p. 4)



Triggering Modal Properties

A source of distraction has certain “triggering modal properties” that may trigger a diversion of attention away from activities critical for safe driving:

- It may be seen (eg advertising billboard) (visual)
- It may be heard (eg ambulance) (auditory)
- It may be felt (eg a tyre blowout) (tactile)
- It may be smelt (eg engine fumes) (olfactory)
- It may be tasted (eg a rotten apple) (gustatory)
- It may be internal (eg “It’s my wedding anniversary today!!”) (internal)

(Hallett, Regan & Bruyas, 2011)

6 Types of Distraction

- Visual distraction
- Auditory distraction
- Tactile distraction
- Olfactory distraction
- Gustatory distraction
- Internal distraction



(Hallett, Regan and Bruyas, 2011)

“““”Types” of Distraction - Issues

- Leads to an unnecessarily truncated repertoire of distraction types
- Fails to recognise that some other types of distraction - eg olfactory distraction - may interfere with activities critical for safe driving.
- “visual distraction” – is more than just “eyes off the road”
- “Biomechanical distraction” – is really a form of structural interference (Kahneman, 1973; McLeod, 1977) that is a consequence of, not a type of, distraction.



Triggered Responses

Each of these types of distraction can, in turn, lead to one or more of a finite set of “triggered responses”:

- Eyes off the road
- Ears off the road
- Body off the road (for cyclists and motorcyclists)
- Nose off the road (for cyclists and motorcyclists)
- Mind off the road

(Hallett, Regan and Bruyas, 2007)

Visual Distraction

“Activities that cause visual distraction (e.g. looking away from the road during texting) appear to be the most dangerous, as has been estimated by odds-ratios.”

(ERSO, EU, 2015, p.5)

Interference

- Triggered Responses will interfere in some way, individually or together, with the performance of activities critical for safe driving.
- We have given very little thought to how, operationally, this interference is characterised.
- As a research community, we could focus more on ***predicting*** the impact of distraction on driving performance rather than on merely ***measuring*** the impact of distraction on driving performance

A Case Study in Prediction



- Expert witness in court case
- Prevent static billboard (bottom left) from being converted to electronic billboard
- Predicted, apriori, what types of crashes could be expected to occur on both approaches to the billboard, and compared predicted crashes with actual crashes

Multi-Step Analytical Process - 1

- Divided each approach to the advertising sign into several specified segments, which were delineated by the intersections and mid-block sections on each approach path to the advertising billboard
- Defined the activities critical for safe driving in each segment eg -
 - “Compliance with signals”
 - “Maintaining lane position and alignment”
 - “Being aware of lateral traffic”etc
- Determined, for each segment, the type of distraction (visual, internal..) most likely to be induced by the advertising billboard

Multi-Step Analytical Process - 2

- Determined, for each type of distraction, the Triggered Responses most likely to occur as a consequence of attending to the billboard eg “eyes off road”
- Determined, for each triggered response, the possible mechanisms by which it could interfere with activities critical for safe driving at each road segment – for example, for “eyes off the road” = missed signals, change blindness, etc
- Determined, for each mechanism of interference, the most likely impact on activities critical for safe driving – for example:
 - (1) risk of collision with entering vehicles
 - (2) risk of collision with crossing pedestrians

Multi-Step Analytical Process - 3

- Determined, for each impact on activities critical for safe driving, the crash type most likely to occur as a consequence, and coded it using the coding scheme used in the State of NSW eg Approach 1:
 - rear-end (RUM 30, 31)
 - side-swipe adjacent vehicle (RUM 33)
 - frontal with lateral traffic (RUM 10)
 - frontal with crossing pedestrians (RUM 00, 01, 02)
 - hit from behind (RUM 30, 31)
 - collision with parked/stationary vehicles (RUM 60, 61).
- Accounted for 39 of the total 97 crashes (40.4%) recorded over the latest 5-year period.

Conclusion



- Need to be clear what we mean by distraction, and how it differs from other forms of inattention
- Vehicle automation will reduce the number of activities critical for safe driving from which drivers can be distracted - and the frame of reference for defining distraction
- Focus more on predicting than on measuring the impact of distraction to force us to define operationally the mechanisms by which it has its impact

ARRB Needs You !!

“ARRB is beginning the search to attract additional world class experts from around the globe, to add to our existing pool of intellectual excellence. We want the best of the best, to join us in our vision to drive innovation to deliver an 'adaptable connected future'. We are growing our intellectual base by building our capacity in fields of critical importance to the road and transport industry, recognising that there are some significant emerging challenges that require deep thinkers that are able to provide solutions to complex problems.”

Interested?

Go to ARRB.com.au

Merci !

Michael A. Regan, PhD

Chief Scientist, Human Factors

Australian Road Research Board (ARRB)

Adjunct Professor, University of NSW,
Australia

2-14 Mountain Street
Ultimo, Sydney NSW 2007
Australia

michael.regan@arrb.com.au



P: +61 2 9282 4402 | **M:** +61 414 014 337