THE FUTURE OF TRANSPORT

The next stage in understanding how novices learn to anticipate hazards

Transport Research in Psychology, Nottingham, 11th April 2019

Dr Neale Kinnear
Head of Behavioural Science

- Understanding the problem
- Theory
- Experimental evidence
- The future of hazard perception

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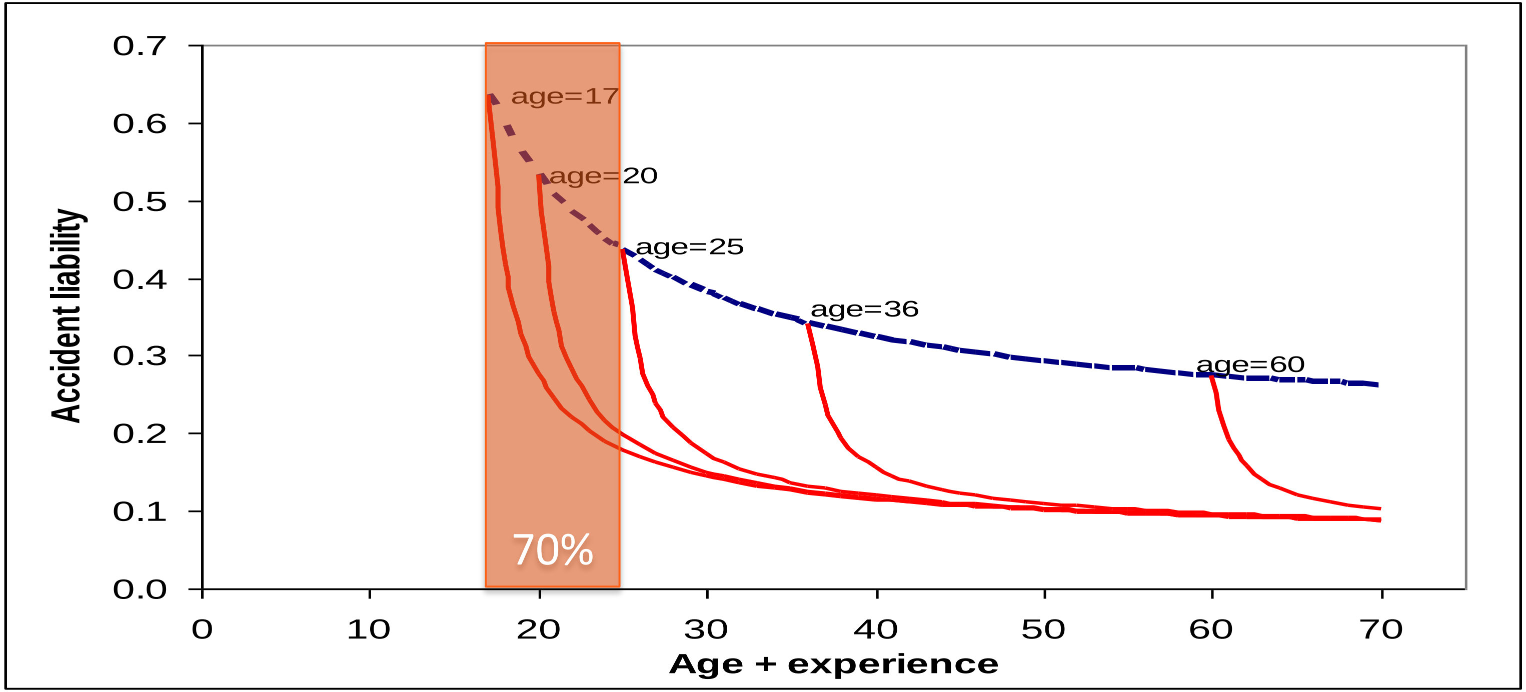
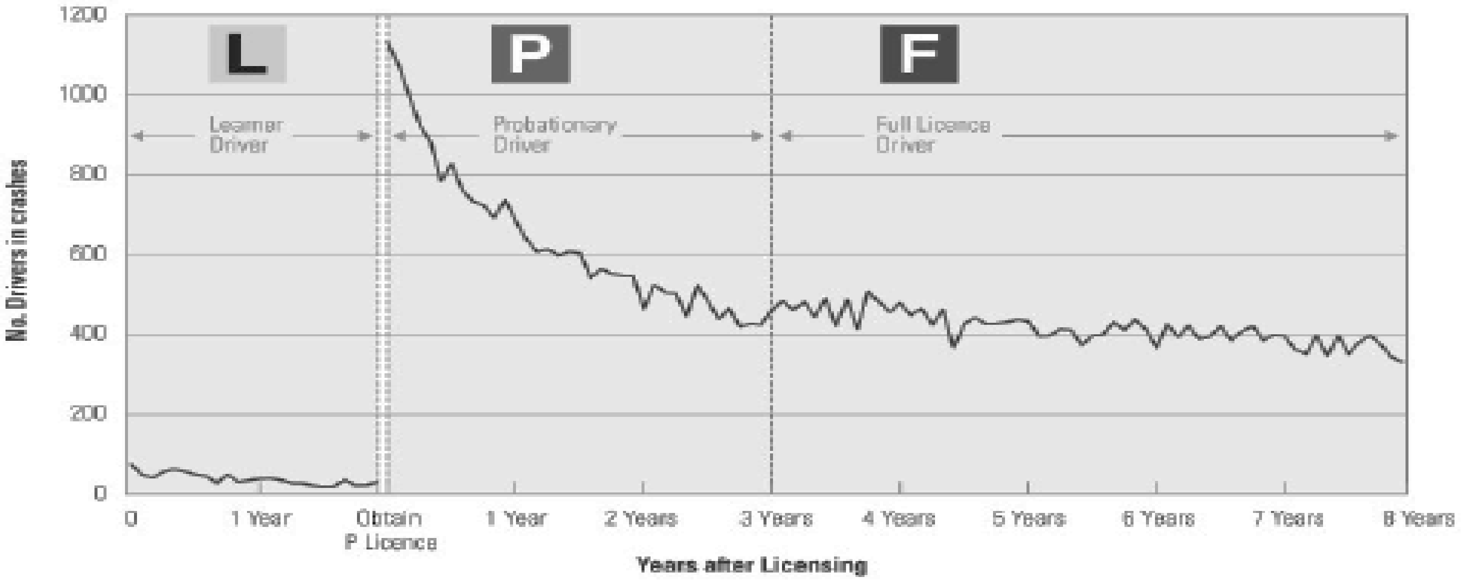
Crash risk by age v experience in Great Britain



Maycock et al (1991)

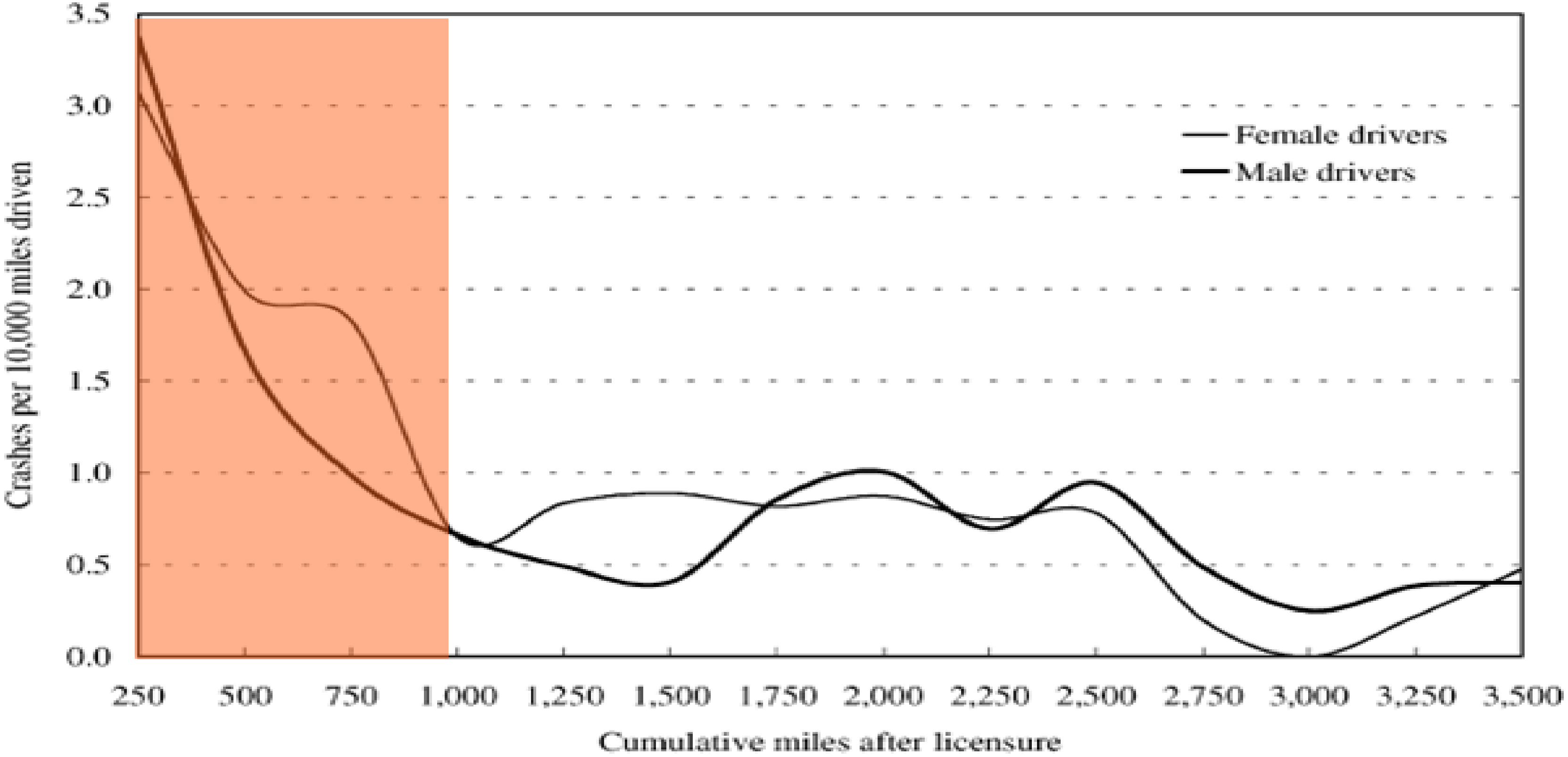
Learner & new driver crash risk in Australia



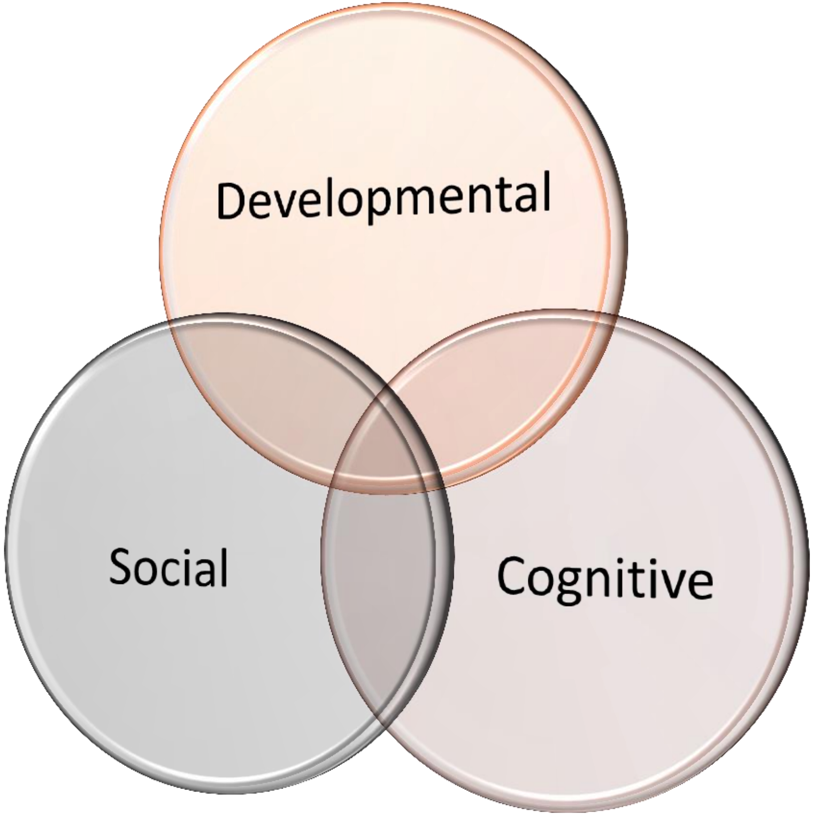
Source: VicRoads

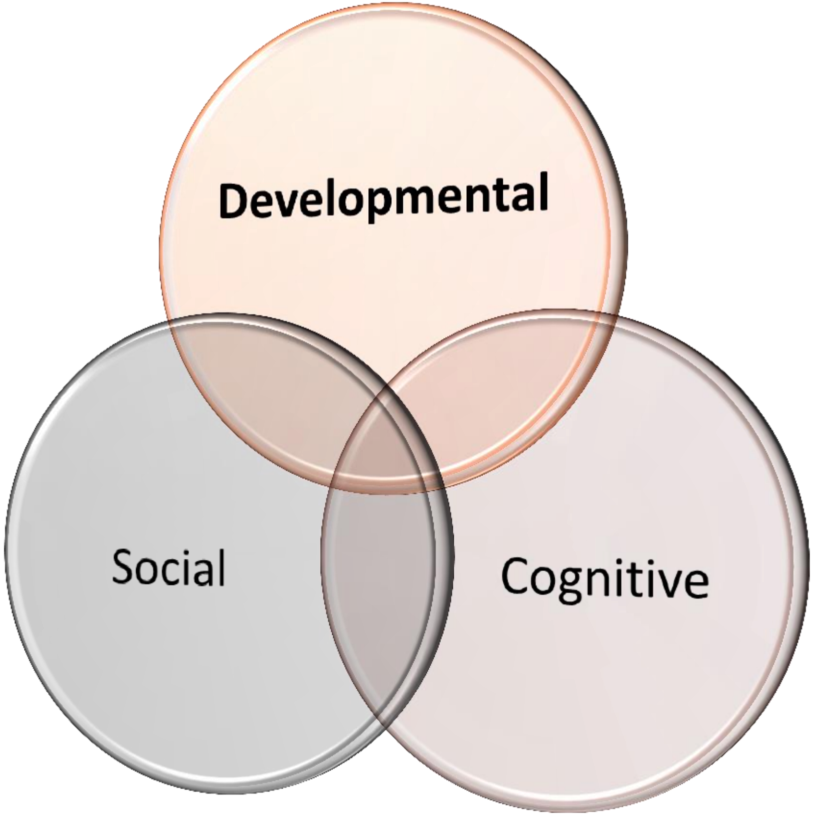
VicRoads (2005). Young driver safety and graduated licensing discussion paper. Melbourne, VicRoads.

New driver crash risk in the USA by mileage



McCartt, A. T., Shabanova, V. I. & Leaf, W. A. (2003). Driving experience, crashes and traffic citations of teenage beginning drivers. *Accident Analysis & Prevention*, 35, 311–320.


Developmental
Social
Cognitive


Developmental
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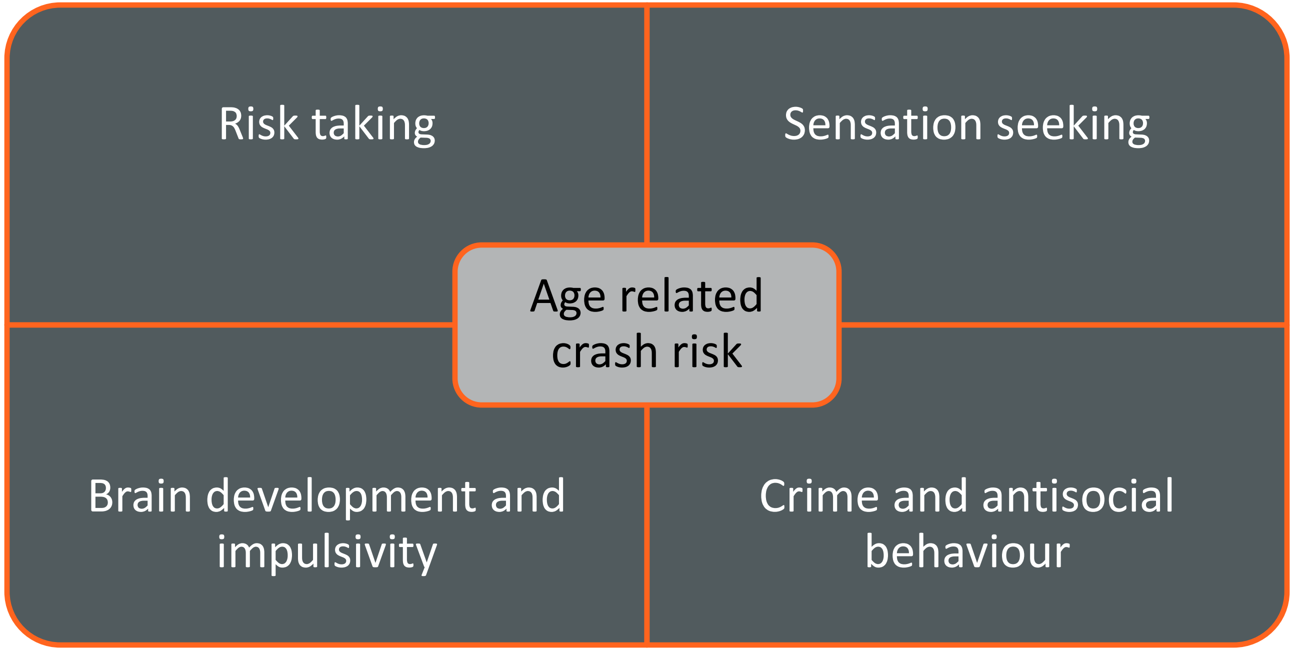
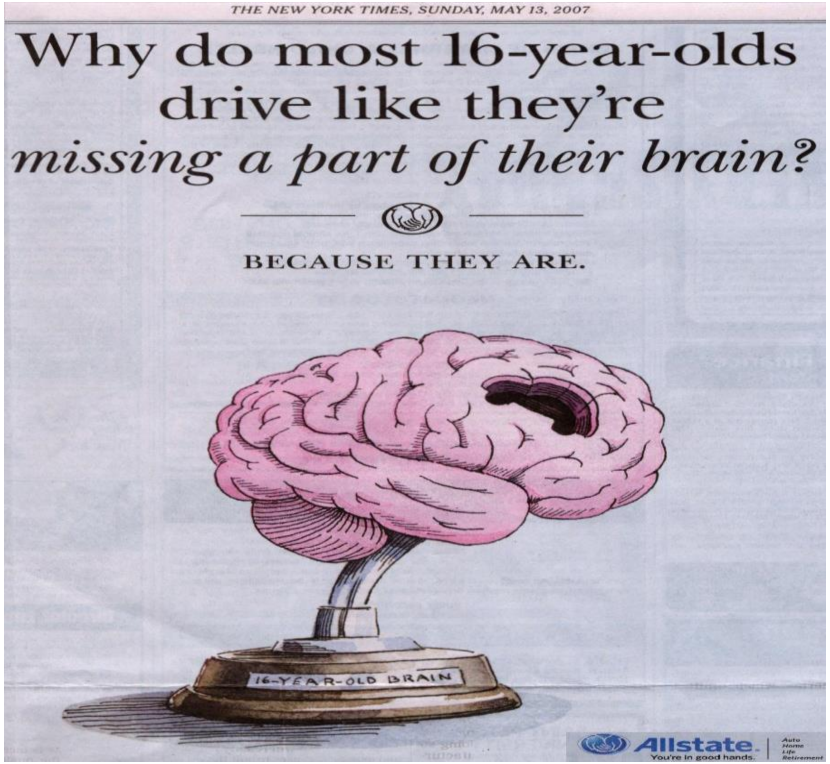
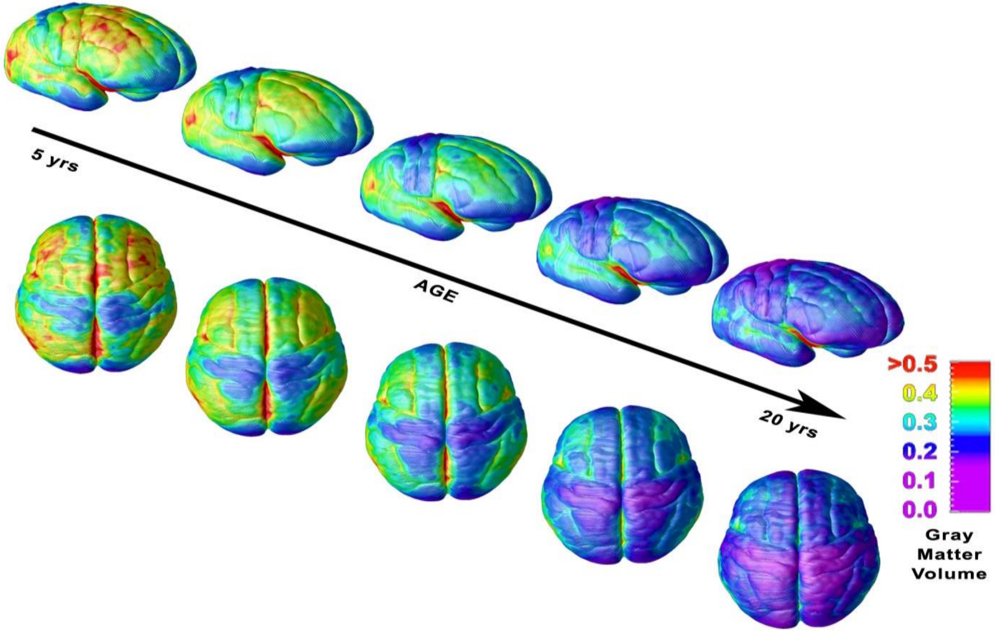
Factors that influence age related crash risk



See McKenna, F.P. (2010). The Public health benefits of road safety education for teenagers. Available at http://www.road-safety.org.uk/research/completed-research/think-piece-by-frank-mckenna/

Brain development

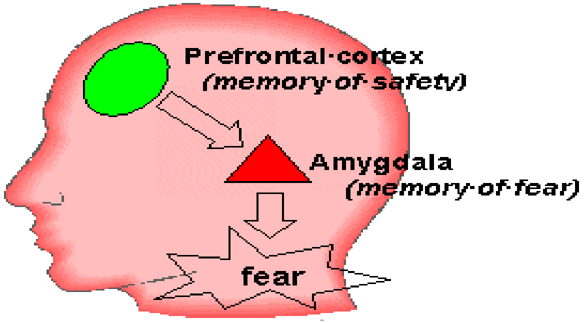


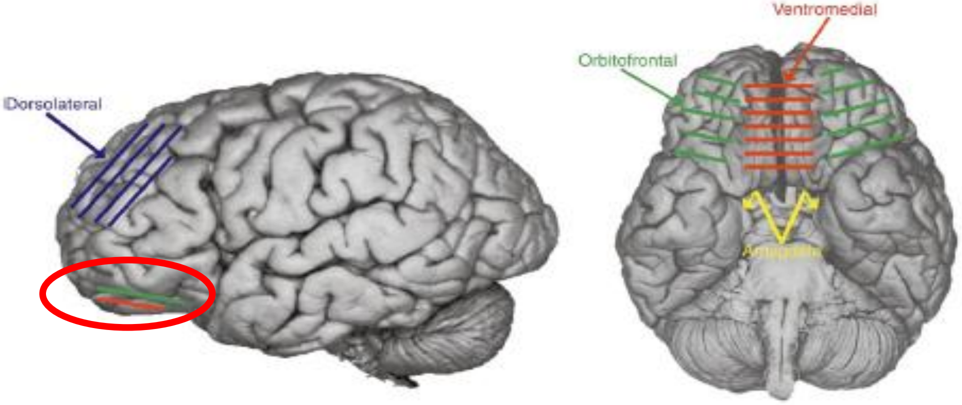


Cognitive functions of the human prefrontal cortex

Functions involve:

- Recognising future consequences resulting from current actions
- Selective attention
- Anticipation
- Emotion regulation
- Reasoning and decision making
- Processing event sequences
- Adaptiveness to new situations





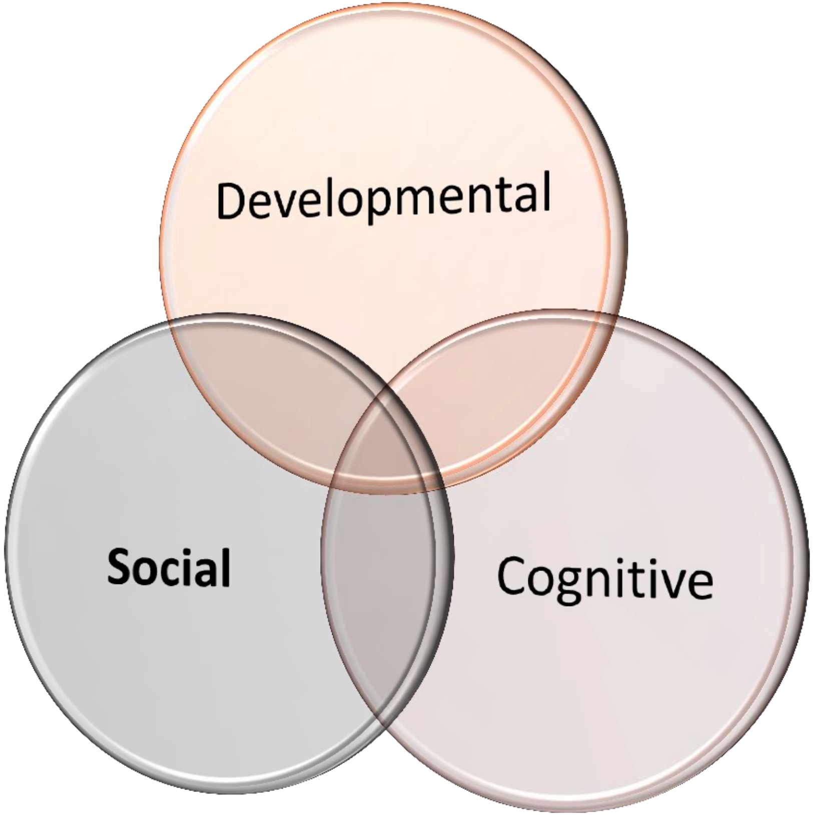
Young drivers in a broader context

Health and wellbeing

- Healthy eating
- Alcohol
- Drugs
- Sexual health
- Mental health
- Lifestyle choices

Enhancing life skills

- Decision making
- Exploring alternatives
- Assertiveness (saying ‘no’)
- Effective communication
- Responsibility
- Self-management


Developmental
Social
Cognitive

Expressive activity: Transport into the adult realm

“Like you’re in control of loads of speed”

‘Driving a car …’

“Instead of using public transport you get to use cars.”

- Is a way of projecting a particular image of myself
- Gives me a feeling of pride in myself
- Gives me the chance to express myself by driving the way I want to
- Gives m
- Gives me the feeling of being in control
- Gives me a feeling of self confidence
- Gives me a sense of personal safety

Automobile = Autonomy + Mobility

Nice silver shiny car. It has to be shiny.”

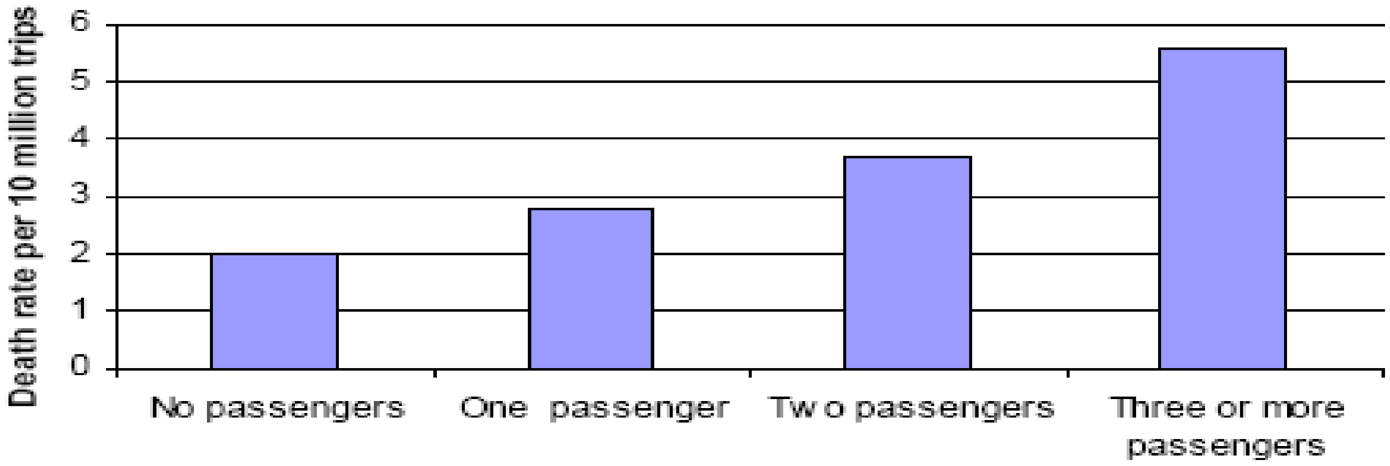
“Windows down, music blaring and just going up and down the street.”

“It would just be great, just the total feeling of freedom.”

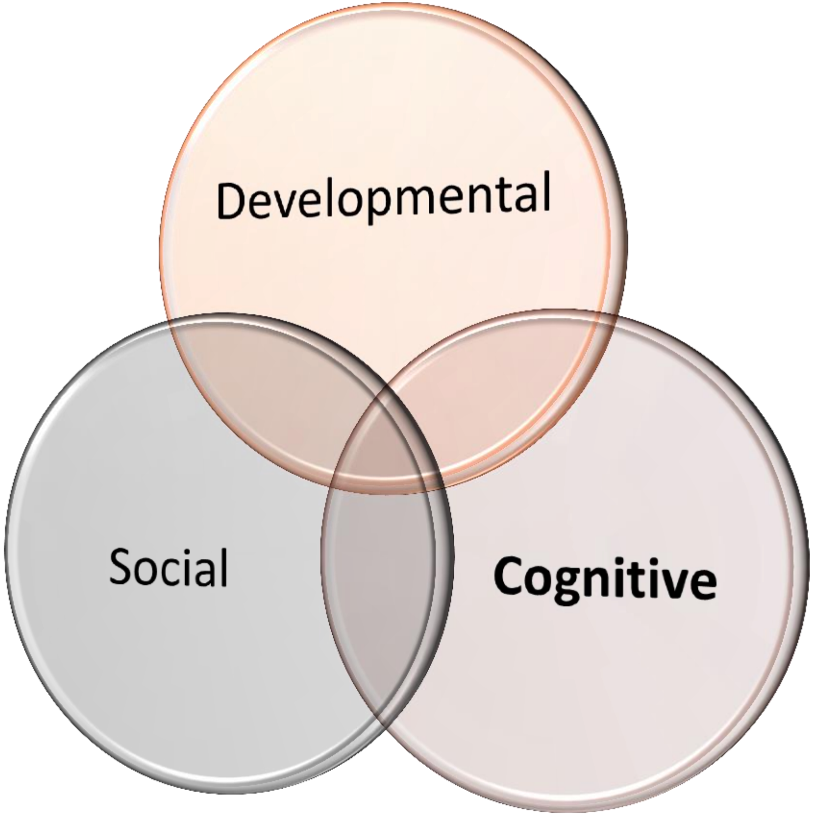
“Not relying on your parents all the time”

“It gives me independence. Be able to go where I want when I want.”

The effect of passengers on crash rate



Source: Chen et al (2000), US


Developmental
Social
Cognitive

Hazard perception & visual scanning

Novice drivers…

- Perceive less holistically
- Perceive hazards less quickly
- Perform smaller horizontal scans
- Look closer to the front of the vehicle
- Check mirrors infrequently

- Glance at objects infrequently
- Utilise peripheral vision inefficiently
- Fixate on fewer objects
- Fixate more on stationary objects
- Are more likely not to perceive a hazard at all

Hazard perception – summary of the evidence

- Hazard perception tests can distinguish between novice and experienced drivers
- The introduction of hazard perception testing in the UK has been related to a reduction in some crash types
- Hazard perception training for newly licensed drivers was found to reduce collision rates for some new drivers in the US
- Hazard perception skill has been related to historical collision involvement
- Trained hazard perception skills have been related to real world improvements, but no assessment of an effect on collisions has been conducted

Attention → Appraisal → Comprehension → Judgement → Decision → Response

What can we do?

Age
Increase licensing age
Phased licensing approach (e.g. GDL)
Coordinated action with health promotion to develop safe road users?
Targeted interventions for distinct groups of higher risk drivers?

Experience
Promote additional and more varied on-road practice – testing and licensing
Phased licensing approach (e.g. GDL)
More effective training of hazard perception / anticipation

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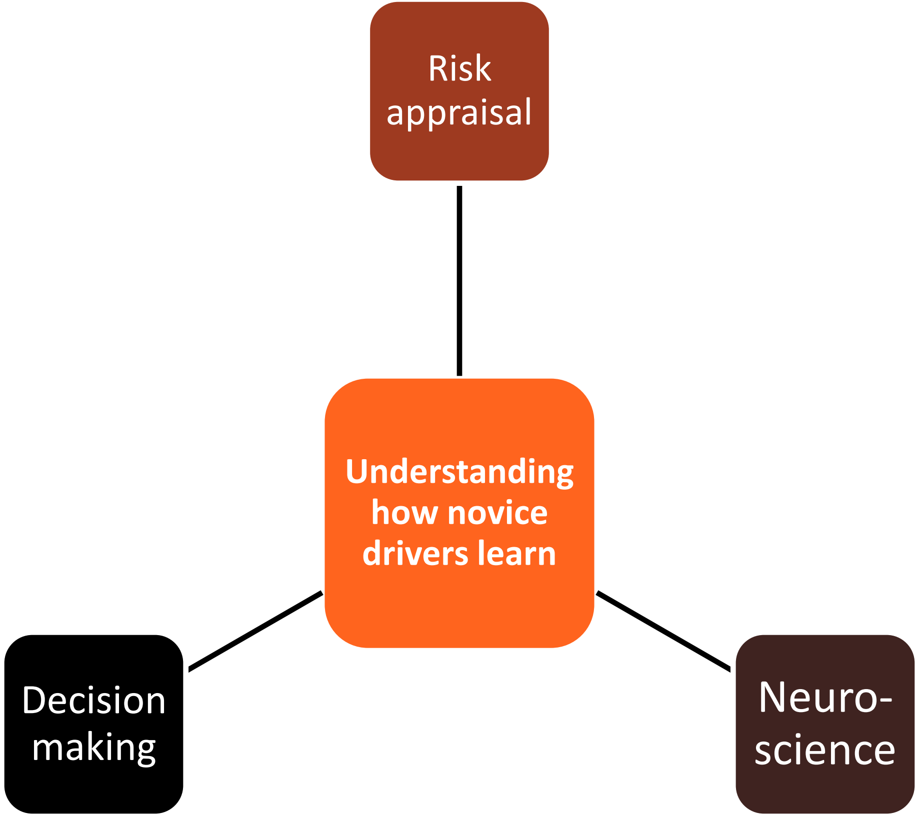

Risk appraisal
Understanding how novice drivers learn
Decision making
Neuro-science

Street Calculus

By Gary Trudeau

Street Calculus.
Copyright 1994
Gary Trudeau

Modern theory of risk appraisal

Slovic et al. (2004)

Two fundamental ways in which humans comprehend risk:		
Analytic system	▪ Uses algorithms and normative rules ▪ Formal logic, and risk assessment	▪ Relatively slow ▪ Effortful ▪ Requires conscious control
Experiential system	▪ Intuitive ▪ Fast ▪ Mostly automatic ▪ Not very accessible to conscious awareness	▪ Developed through evolution ▪ The most natural and most common way for humans to respond to risk ▪ Relies on images and associations, linked by experience to emotions (a feeling that something is good or bad).

Emotion, Feelings and Decision Making

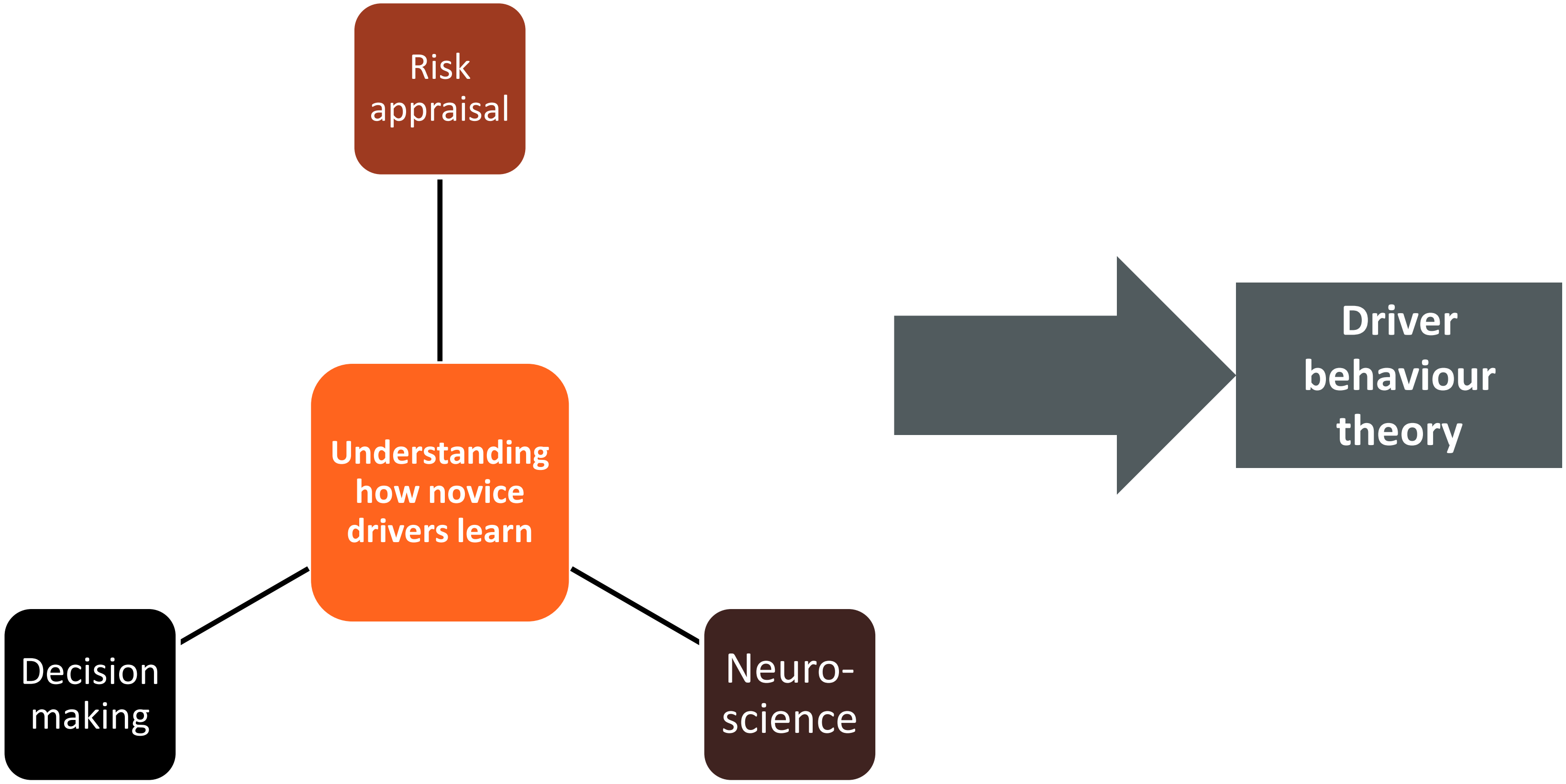
Peters et al. (2006); Damasio (1994; 2001)

- Feelings act as information to guide and bias judgement and decision processes. The feelings themselves are based on prior experience of situations.
- By translating complex scenarios into feelings, decision making can do without continuous conscious attention and reasoned logic.
- Somatic Marker Hypothesis: *"Somatic markers (SM) are a special instance of feelings generated from emotions. Those emotions and feelings have been connected by learning to predicted future outcomes of certain scenarios. When a negative SM is juxtaposed to a particular future outcome the combination functions as an alarm bell"*

What Drivers Tell Us

Focus group quotes from inappropriate high speed study

"I think your body knows you're outside your comfort zone. It just registers something and you say 'back again' instantly, to whatever speed you're comfortable"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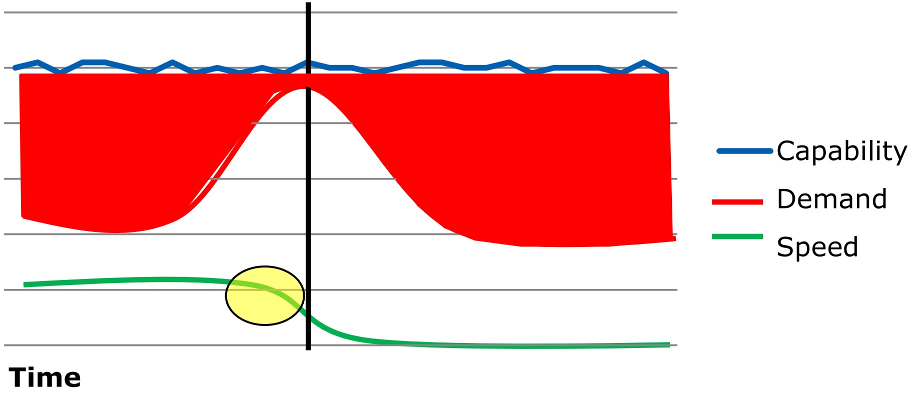
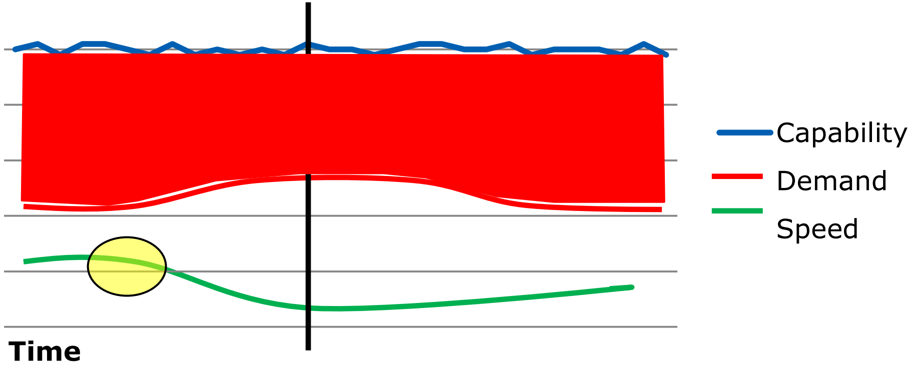
Driver behaviour theory

Inexperienced Driver



Experienced Driver



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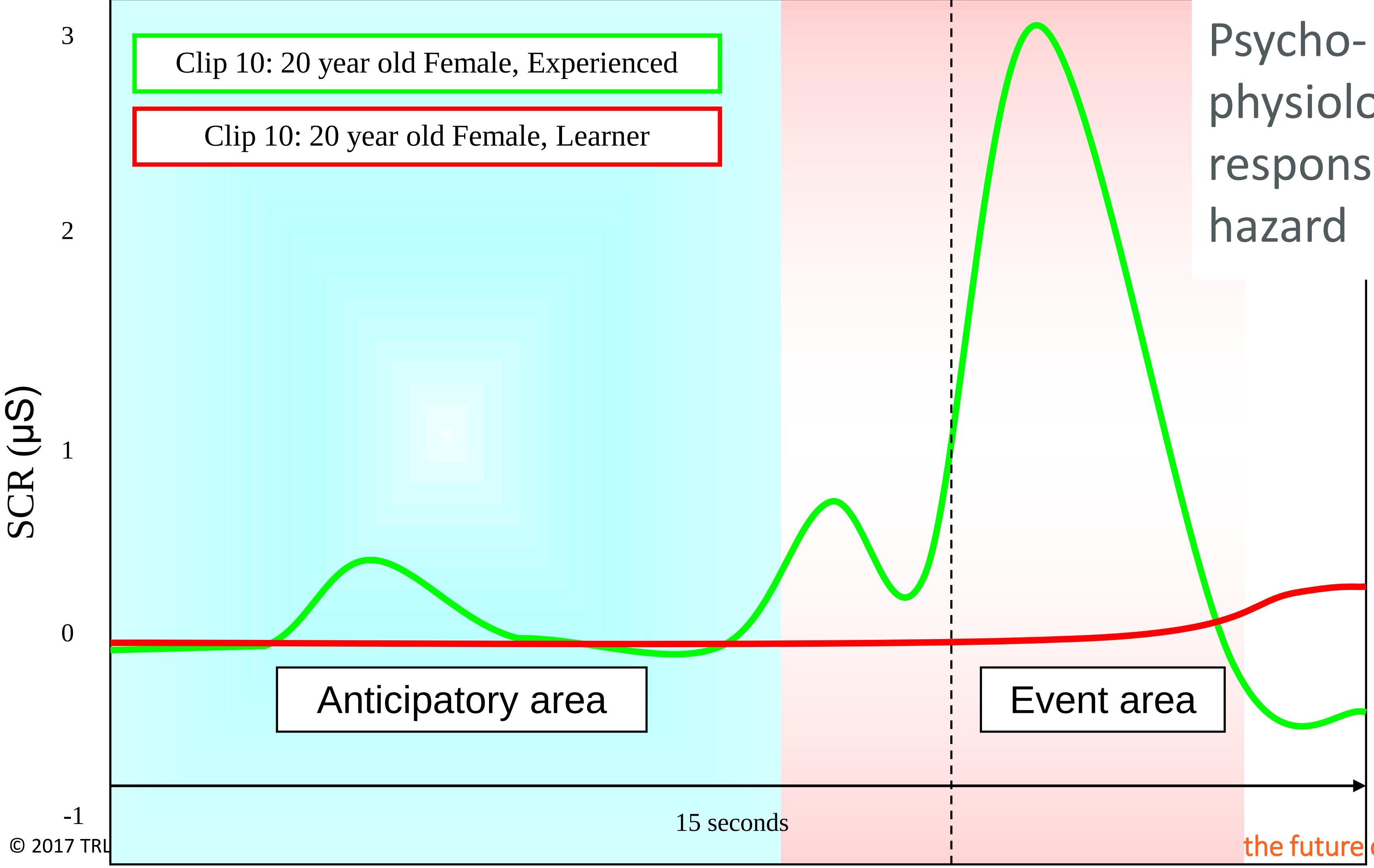
Driving as you feel

An investigation of physiological responses to developing hazards
(Kinnear et al., 2013)

SCR Experiment

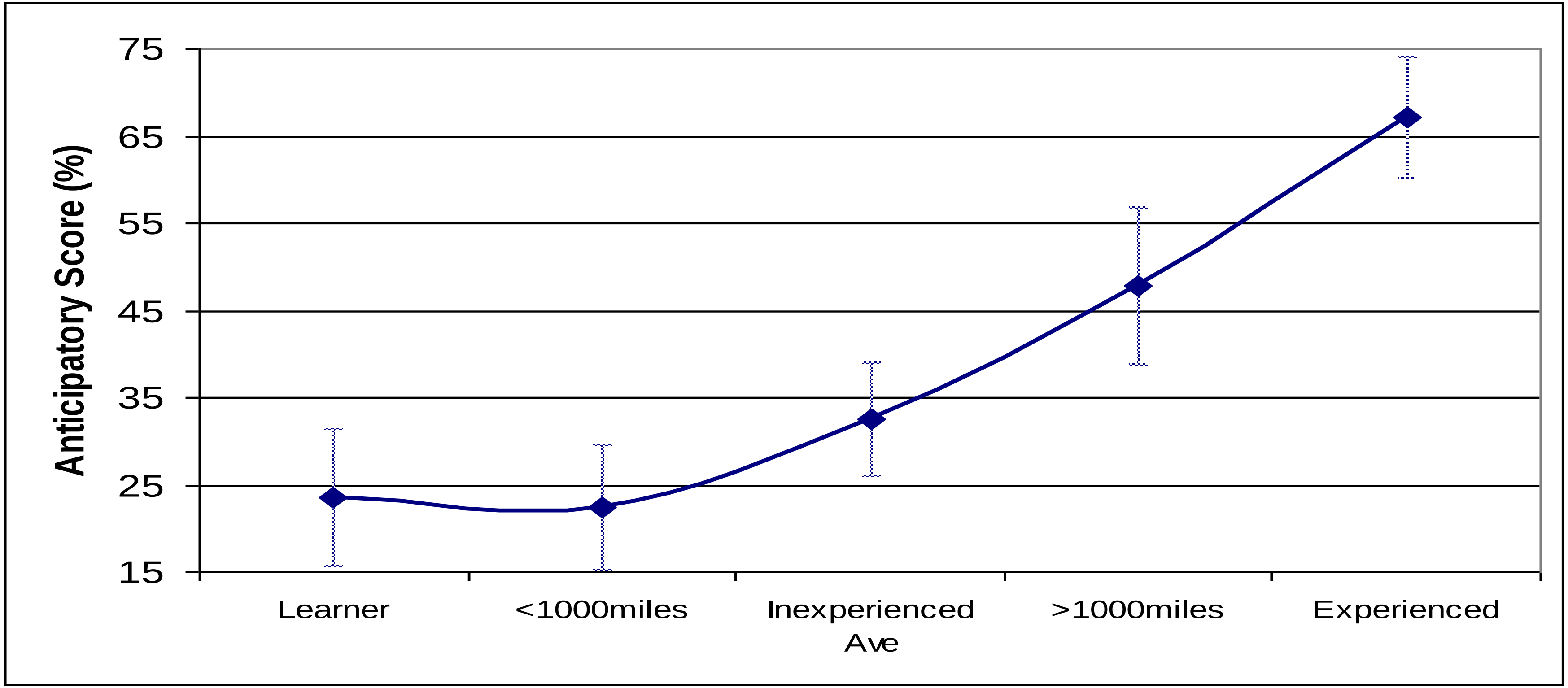
- **Validated DSA hazard perception clips**
- **Learner v Inexperienced (<3 years) v Experienced (3+ years) (n=50)**
- **Measures:**
  - **Cognitive hazard ratings**
  - **Skin Conductance Response (SCR)**

Psycho-physiological response to a hazard



Experiment 2 – Hazard Perception clips

A learning curve?



SCR and driving literature

Paper	Summary of finding
Hulbert (1957)	Both reported that drivers demonstrated Michaels (1960) distinct measurable SCRs when driving and that they occurred relatively frequently
Taylor (1964)	Reported supporting Michaels results that observable traffic hazards were related to increases in SCR activity
Helander (1978)	Inferred that SCR precedes the release of the accelerator by 0.2secs and the pressing of the brake by 1.9secs
Crundall et al. (2003)	Police drivers produced significantly more SCRs – ‘considered indicative of sudden increases in hazard awareness’ – than experienced and novice groups.

- Understanding the problem
- Theoretical understanding
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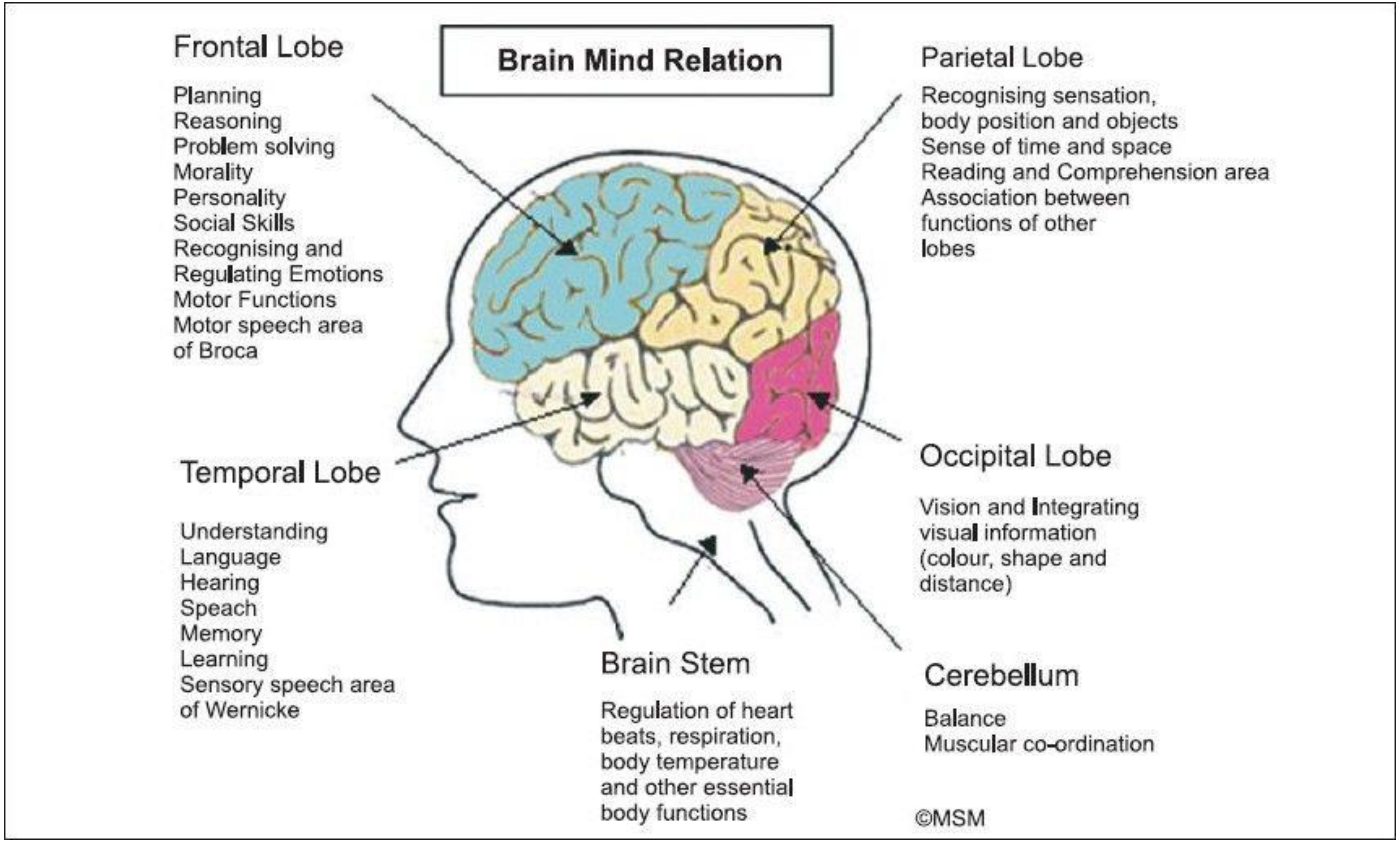
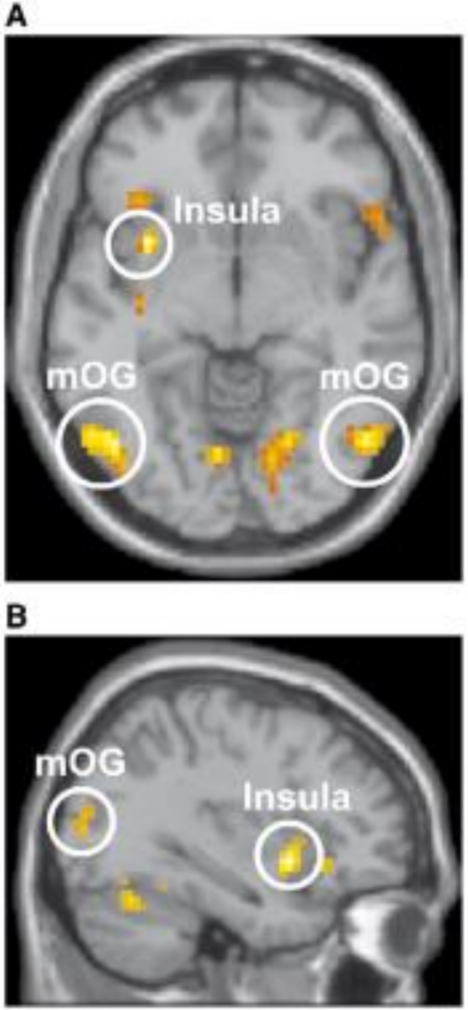

Brain Mind Relation
Frontal Lobe
Planning
Reasoning
Problem solving
Morality
Personality
Social Skills
Recognising and
Regulating Emotions
Motor Functions
Motor speech area
of Broca
Parietal Lobe
Recognising sensation,
body position and objects
Sense of time and space
Reading and Comprehension area
Association between
functions of other
lobes
Temporal Lobe
Understanding
Language
Hearing
Speach
Memory
Learning
Sensory speech area
of Wernicke
Occipital Lobe
Vision and Integrating
visual information
(colour, shape and
distance)
Brain Stem
Regulation of heart
beats, respiration,
body temperature
and other essential
body functions
Cerebellum
Balance
Muscular co-ordination
©MSM

Neural correlates of driving

Fuction	Regions
Judgement	Fronto-parietal
Motor skills	Pre-motor cortex, cerebellum, basal ganglia
Higher order cognition	Dorsolateral, medial and anterior prefrontal regions
Executive, attentional control, goal-directed behaviour	Fronto-basal ganglia loop

Neural substrates of driving behaviour

Spiers & Maguire (2007)



Physiological Biomarkers of Hazard Perception Among Novice and Experienced Young Drivers

Johns Hopkins Bloomberg School of Public Health | Johns Hopkins Center for Injury Research and Policy

Ehsani, Seymour, Chirles & Kinnear (2019)

Aims:

1. Create and validate a video library of driving scenarios
2. Replicate and extend what is known about physiological markers of hazard detection in experienced versus novice adolescent drivers
3. Identify patterns of neural activation during hazard perception that differ between experienced and novice young drivers

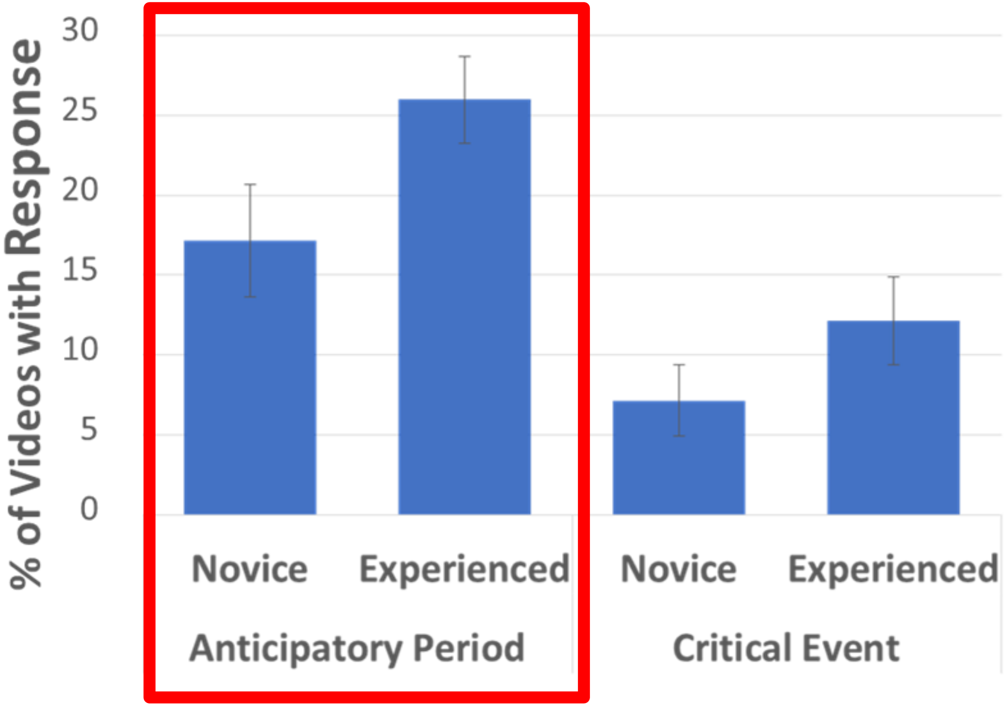
Development of hazard clips

- SHRP2 dataset: Largest naturalistic driving dataset from 3,400 drivers
- Over 40,000 clips of real world driving footage
- 1,034 potential near-crash events identified, filtered to 183
- Further quality filtering reduced the final sample to thirty 90-second clips

Study 1: Validation of clips

- Novice v Experienced drivers (N=31)
- Viewed 30 hazard and 30 non-hazard clips and rated for risk
- Hazard videos were identified as more risky by both groups
- Relative to experts, novice drivers:
  - Did not rate hazards in medium and heavy traffic as highly
  - Did not rate side-swipe vehicle conflicts as highly
  - Did not rate short lead-time hazards as highly

Skin conductance - interim results



Next steps for this study

- Final analysis of the replication of skin conductance studies
- Analysis of fMRI data: novice versus experienced drivers
- Develop full funding proposal

Final thoughts

The future of Hazard Perception

- **Interventions**: Designed to effectively support and promote efficient learning. Re-testing?
- **Measurement**: Bio-physiological indicators / neurological markers related to behavioural outcomes
- **Presentation**: Immersive Virtual Reality / Augmented Reality / CGI. Real-world?

Questions?

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