The next stage in understanding how novices learn to anticipate hazards

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Dr Neale Kinnear
Head of Behavioural Science
Understanding the problem

Theory

Experimental evidence

The future of hazard perception
• Understanding the problem

• Theory

• Experimental evidence

• The future of hazard perception
Crash risk by age v experience in Great Britain

Maycock et al (1991)
Learner & new driver crash risk in Australia

New driver crash risk in the USA by mileage

Developmental

Social

Cognitive
Factors that influence age related crash risk

- Risk taking
- Sensation seeking
- Brain development and impulsivity
- Crime and antisocial behaviour

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
Expressive activity: Transport into the adult realm

‘Driving a car …’

- 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 me the feeling of being in control
- Gives me a feeling of self confidence
- Gives me a sense of personal safety

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

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

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

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

“Not relying on your parents all the time”

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

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

Automobile = Autonomy + Mobility

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The effect of passengers on crash rate

Source: Chen et al (2000), US
Developmental

Social

Cognitive

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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.
### 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**
• Understanding the problem
• Theory
• Experimental evidence
• The future of hazard perception
Understanding how novice drivers learn

Risk appraisal

Decision making

Neuro-science
Street Calculus
By Gary Trudeau

Street Calculus.
Copyright 1994
Gary Trudeau

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Modern theory of risk appraisal
Slovic et al. (2004)

Two fundamental ways in which humans comprehend risk:

<table>
<thead>
<tr>
<th><strong>Analytic system</strong></th>
<th><strong>Experiential system</strong></th>
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<tbody>
<tr>
<td>Uses algorithms and normative rules</td>
<td>Intuitive</td>
</tr>
<tr>
<td>Formal logic, and risk assessment</td>
<td>Fast</td>
</tr>
<tr>
<td>Relatively slow</td>
<td>Mostly automatic</td>
</tr>
<tr>
<td>Effortful</td>
<td>Not very accessible to conscious awareness</td>
</tr>
<tr>
<td>Requires conscious control</td>
<td>Developed through evolution</td>
</tr>
<tr>
<td></td>
<td>The most natural and most common way for humans to respond to risk</td>
</tr>
<tr>
<td></td>
<td>Relies on images and associations, linked by experience to emotions (a feeling that something is good or bad).</td>
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</table>
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”
Understanding how novice drivers learn

- Decision making
- Neuroscience

Risk appraisal

Driver behaviour theory

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Inexperienced Driver

Experienced Driver
• Understanding the problem
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Driving as you feel
An investigation of physiological responses to developing hazards
(Kinnear et al., 2013)

<table>
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<tr>
<th>SCR Experiment</th>
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<tbody>
<tr>
<td>▪ Validated DSA hazard perception clips</td>
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<tr>
<td>▪ Learner v Inexperienced (&lt;3 years) v Experienced (3+ years) (n=50)</td>
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<tr>
<td>▪ Measures:</td>
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<td>▪ Cognitive hazard ratings</td>
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<td>▪ Skin Conductance Response (SCR)</td>
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</table>
The diagram illustrates the psycho-physiological response to a hazard. It compares two clips:

- **Clip 10: 20 year old Female, Experienced**
- **Clip 10: 20 year old Female, Learner**

The response is measured in SCR (µS) over a 15-second period. The diagram is color-coded to differentiate between the anticipatory area and the event area. The anticipatory area is shown in blue, and the event area in red.

The future of transport.
Experiment 2 – Hazard Perception clips

A learning curve?
## SCR and driving literature

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

<table>
<thead>
<tr>
<th>Function</th>
<th>Regions</th>
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<tbody>
<tr>
<td>Judgement</td>
<td>Fronto-parietal</td>
</tr>
<tr>
<td>Motor skills</td>
<td>Pre-motor cortex, cerebellum, basal ganglia</td>
</tr>
<tr>
<td>Higher order cognition</td>
<td>Dorsolateral, medial and anterior prefrontal regions</td>
</tr>
<tr>
<td>Executive, attentional control, goal-directed behaviour</td>
<td>Fronto-basal ganglia loop</td>
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</table>
Neural substrates of driving behaviour
Spiers & Maguire (2007)
Physiological Biomarkers of Hazard Perception Among Novice and Experienced Young Drivers
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

![Graph showing the percentage of videos with a response for novice and experienced drivers during the anticipatory period and critical event. The graph indicates a higher percentage of reactions among experienced drivers.](image)
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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