Surviving Driving:
Getting there, and back again

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Te Whare Wānanga o Waikato

TRG
Transport Research Group

Driving a car is difficult

I find driving difficult for me, probably because it's new to me, but I have been about 10 times, shouldn't it be becoming easier? Each time I sit in that driver's seat I feel incredibly anxious. I have a bad habit of drifting to the right but I cant feel it when it happens because I have a hard time seeing the lane. Also tonight I drove up to the gas station and when pulling up to the pump I almost ran into a pole...because I hit the gas instead of brake. I am 17 and want to drive to school my senior year. I'm trying to become comfortable with driving but it's hard and scary. Please help. (Jane, 2019)

Remembering not only which way to turn the steering wheel, but how far fazes many, and then add to the mix throttle response, clutch movement, and what the hell is that kid on the bike about to do, has been known to finish people off!
Just use all the pedals as if there's an egg under each one, and you'll be fine!
Very best of luck with your driving! (Kristie, 2019)

…but with practice
it becomes very easy

While I was driving to work today I thought about 'how' I was driving without actually thinking about it! I found it really difficult to go back to feeling the clutch, checking the mirrors etc, in a conscious way. I just do it! *(Mabel, 2012)*

Everyday driving

we don't need to think about the journey,
we simply get in the car and go

What is Everyday driving ?

Driving without awareness

The sense of driving without awareness is an experience familiar to most drivers; a sudden realisation that you have no recollection of the past several minutes of driving, and that you have arrived at this point in the journey with little or no conscious attention to the surrounding traffic. As with other areas of skilled performance, many aspects of driving become automated with practice (Charlton & Starkey, 2011)

Most drivers are driving without awareness, most of the time

We don’t always have to pay attention

Consider the difference between processing cues for guidance vs processing for meaning

Pedestrians texting and talking were inattentionally blind to the presence of a money tree, but avoided bumping into it

Hyman, Sarb, and Wise-Swanson (2014)
Inattentional blindness for money tree

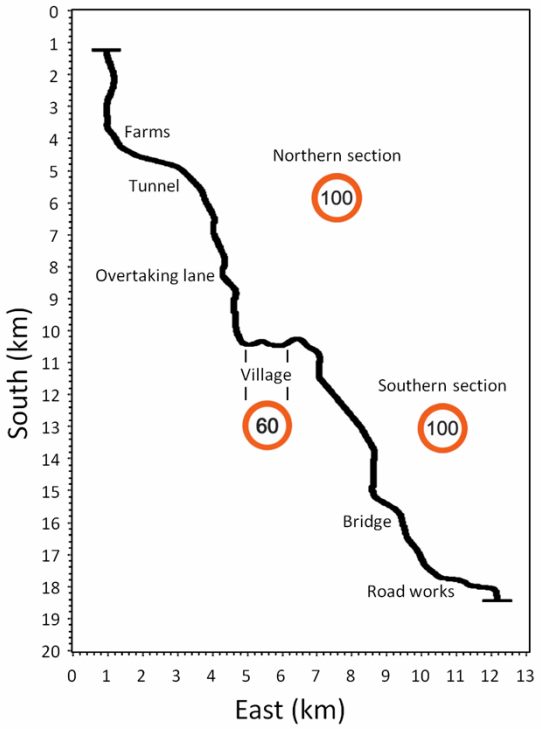
Everyday examples of “automatic” activities are some of the least well-studied, such as walking, bicycle riding, assembly-line work, washing dishes … and driving

Can these continuous chains of behaviour be considered automatic?

Everyday driving experiment

Drove a 24 km-long section of rural road
20 times over the course of 2 ½ months

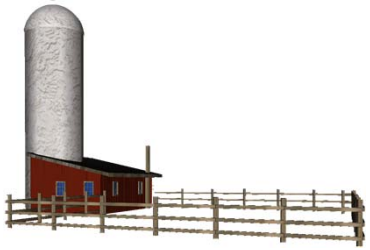
(Charlton & Starkey, 2011, 2013)



By sessions 5 & 6 participants reported “driving without thinking about it” “on autopilot” “zoning out”

What does everyday driving performance look like?

- Increased speeds
- Decreased speed variability
- Change blindness / inattention blindness for familiar road features



Participants did not detect removal of prominent buildings or changes in signs, including change from English to German wording

What do drivers notice?

Guidance/confirmatory cues
(for continuous control feedback)

Removal of centreline detected most often and most rapidly

6.77m away in Session 3 to 13.34 m in Session 12, and 19.66 m by Session 19

No detection if dashed line was replaced by solid line – so not just result of foveal location

With repeated exposure drivers develop inattention blindness for road signs

What drivers don't notice

Drivers notice as few as 1 in 10 road signs and have very poor memory for signs they've just passed (6% recall - 9% recognition)

Changes to existing signs are the least noticeable

What changes do drivers notice?

#1 change detected by drivers – removal of centrelines
#2 - removal of edgelines

Preconscious guidance cues

Curve warnings that highlight the perceptual features of the curve work best, particularly when drivers aren't paying attention

(Charlton, 2004; 2007a)

Gateways & Urban Thresholds

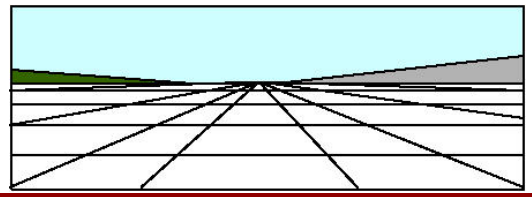
Thresholds work even without speed restriction information (i.e., blank signs)

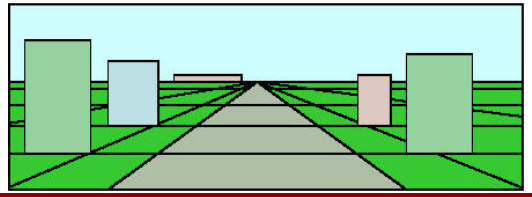
(Charlton, Alley, Baas, & Newman, 2002)

Visible features of the road and road environment can function as accelerators or decelerators

Accelerators	**Decelerators**
Long straight road sections or intersections)	Short straight sections (many bends
Physical speed limiters not present	Physical speed limiters present
Open, clear road environment	Closed, irregular vertical elements
Wide road	Narrow road
Smooth road surface	Rough road surface

(SWOV, 2012)





Development of an SER design template

for Glen Innes / Pt England

(Charlton et al, 2010)
Funded by FRST

Local roads

Collector roads

Making different roads types visually distinct, using natural accelerators and decelerators

Before

Local roads

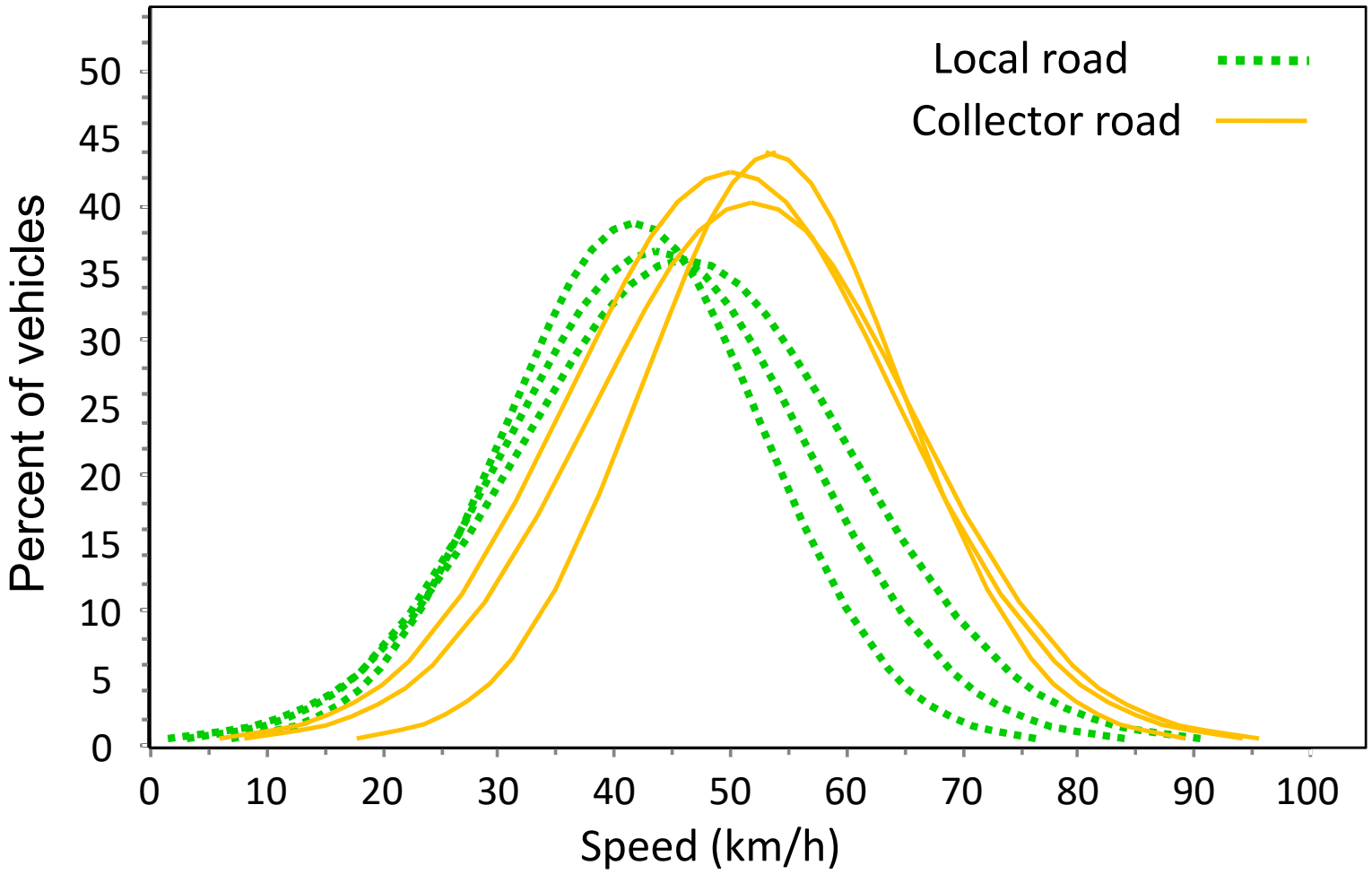
Collector roads

After

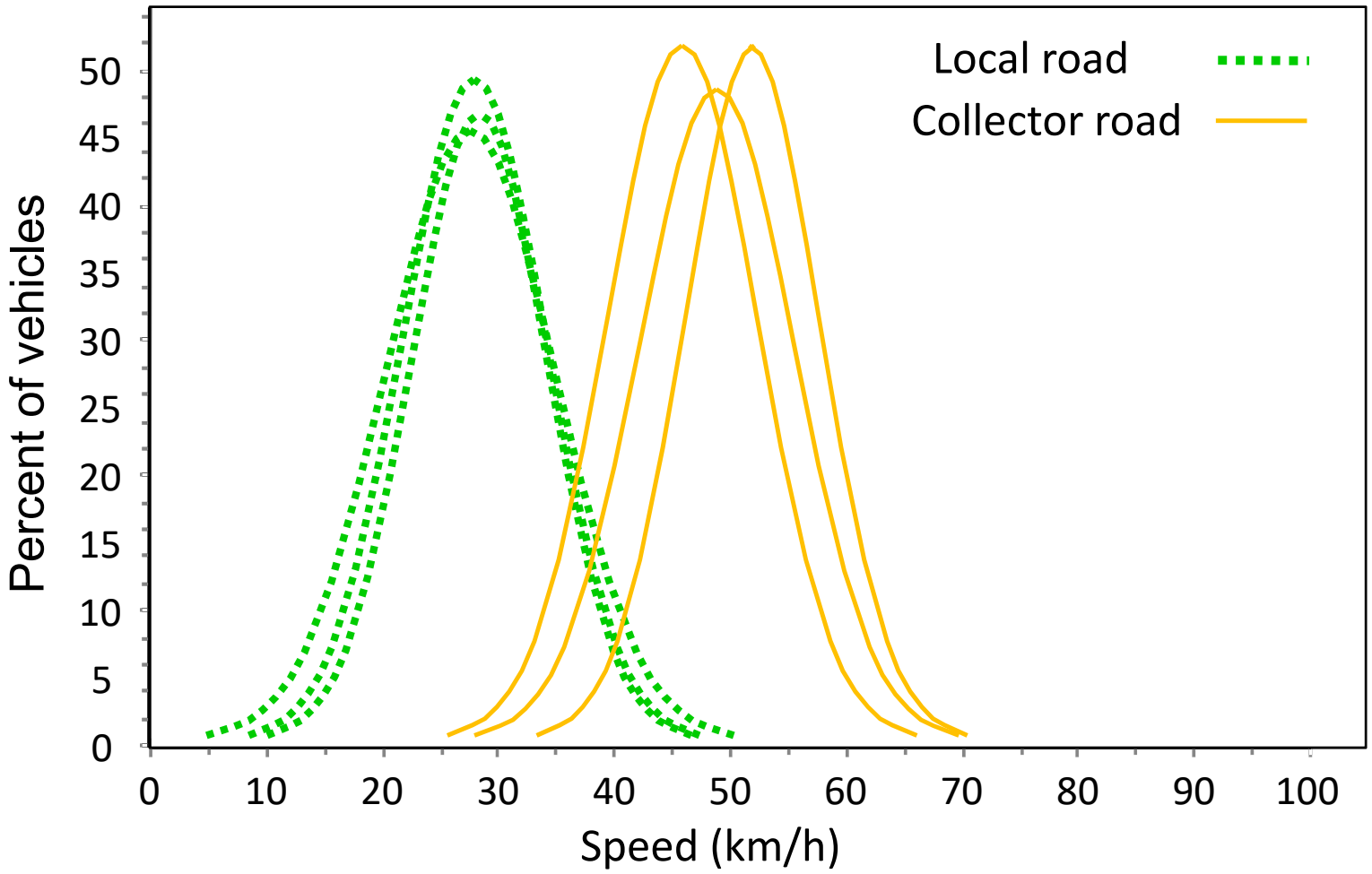
Local roads

Collector roads

Pre-treatment speeds



Post-treatment speeds



Results

A decrease in local road speeds

Significant homogeneity of speeds

43% reduction in crashes (over 5 yrs)

50% reduction in crash costs

Health benefits 3x the road safety benefits

No speed signs

No enforcement

Self-Explaining Roads

Currently, we don’t do a very good job at telling drivers what kind of road they are using

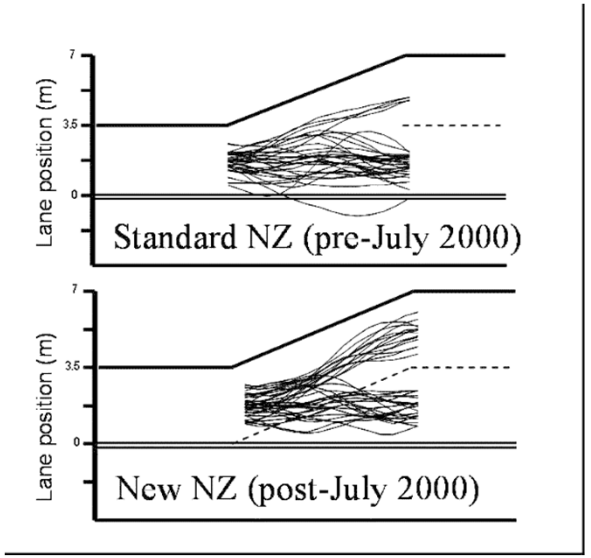
These NZ roads look very similar

but they all have different speed limits

Lines function as guidance cues

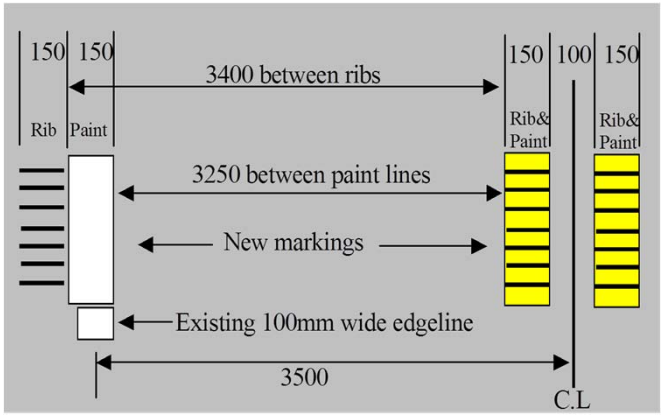
The addition of a continuity line (guidance cue) significantly increased the number of drivers keeping left

(Charlton et al, 2001; Charlton, 2007b)



Lines function as guidance cues

South Waikato & Taupo
Target 2010 Project



(Charlton, 2006)

Significant safety gain
with no increase in speed

Pre treatment | Phase 1 | Phase 2

Lines function as risk cues

Perceived risk, speed, & countermeasures

(Charlton & Starkey, 2016)

Funded by the AARF

75 participants drove a series of roads in the simulator, controlling their speed and steering

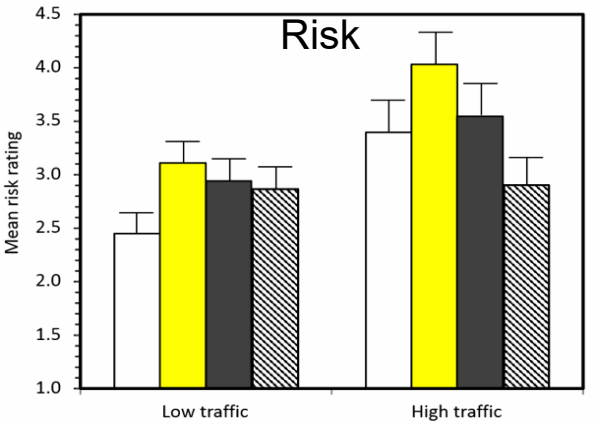
Median treatments (dashed white lines, double yellow lines, wide centre lines, and wire rope barriers) in both high & low traffic

Two warning treatments
(high crash area sign and police car)

Speed reduction treatments
Narrow lanes and lower speed zone

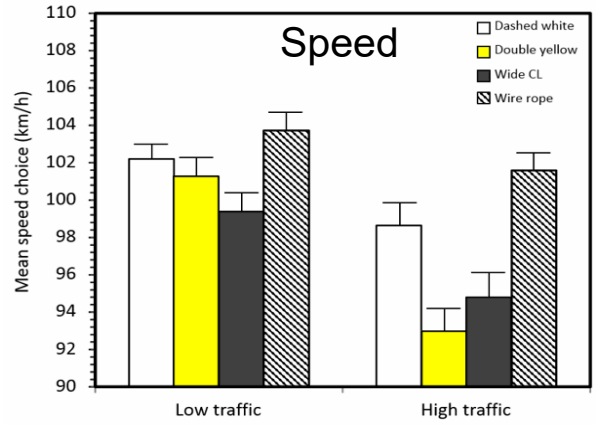
Under high traffic conditions, double yellow lines and wide centre lines increased drivers' sense of risk, and were associated with lower speeds

These effects were most pronounced for double yellow centre lines



Wire rope barriers elevated risk perception somewhat, but no effect of traffic density on speed or risk ratings

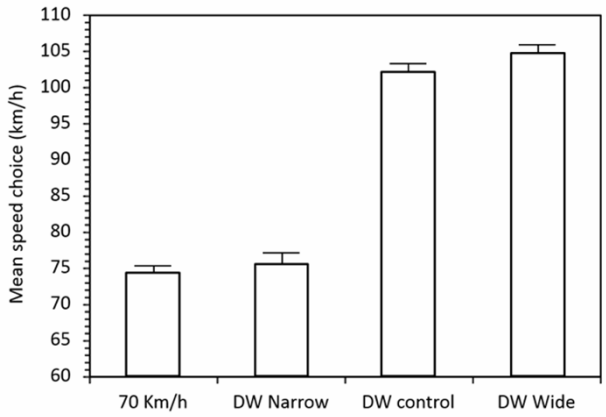
Wire rope barriers minimised the risk effect of high traffic



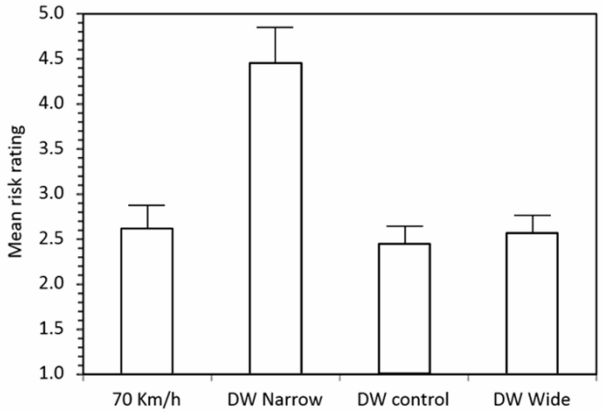
Double yellow lines in high traffic had similar risk ratings as narrow roads, and reduced speeds

Wire rope medians produced speeds as high as wide lanes

Speed



Risk



Road markings can also be used to signal transitions from one type of road to another

(Charlton & Starkey, 2018)
Funded by the NX2 Consortium

In order to promote appropriate expectations (and speeds) as drivers leave the safety of the 5-star motorway, the road conditions that lay ahead must be clearly communicated to drivers

Roads

Motorway clips
approx. 155 sec duration
1, 3, 4 order counterbalanced

Transition clips
approx. 66 sec duration
1, 3, 4 order counterbalanced

Hazard clips
60 sec duration,
55 km/h curve located 40-50 sec
1, 3, 4 order counterbalanced

Trial 1

Trial 2
(no hazard
“foil”)

Trial 3

Trial 4









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What road markings will most quickly prepare drivers for the hazards associated with 2* rural roads?

(in this case a 55 km/h curve)

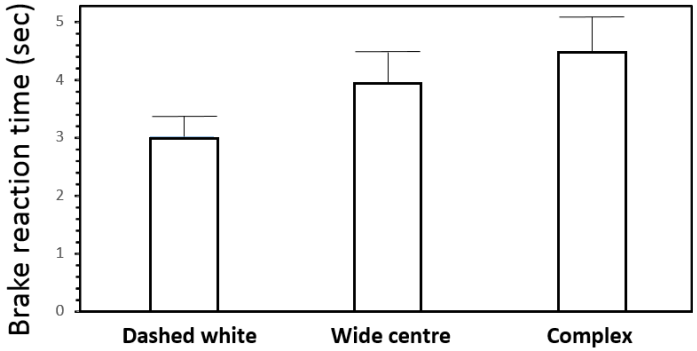
50 fully licenced drivers (28 female) completed the experiment
Mean age was 36.58 years (SD = 13.95, range 16 – 64 years)

Three types of transition sections:
dashed white, wide centre lines, complex centre lines

How quickly did drivers slow down when they came to the 55 km/h curve warning sign?

(BRT measured from when sign came into view)

Significantly faster after driving on dashed white
(as compared to wide centre line $p = .018$, or complex centre line, $p < .001$)



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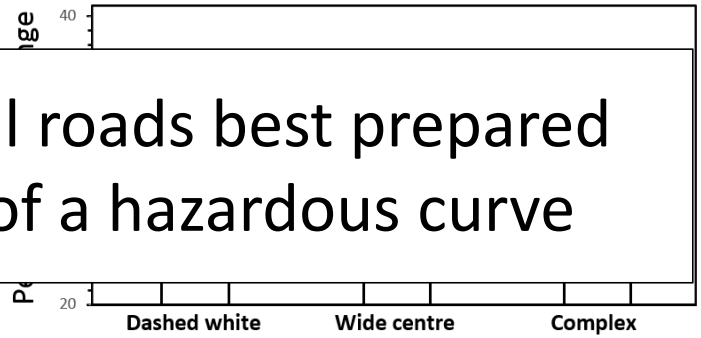
Immediate change to 2* rural roads best prepared drivers for the appearance of a hazardous curve

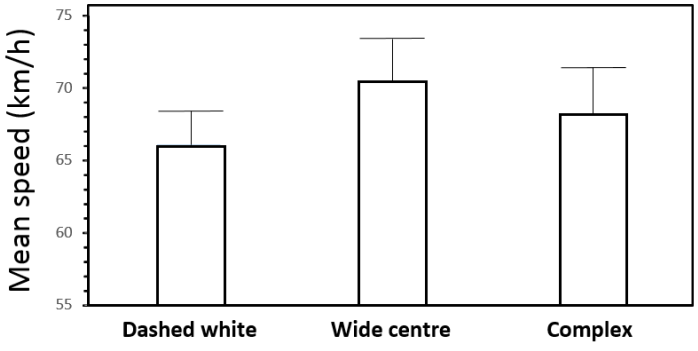


Slowed significantly more after driving on dashed white, $p = .024$
(as compared to wide centre line, not diff to complex)

What speed did drivers traverse the curve?

(as measured over 10 sec starting with warning sign)

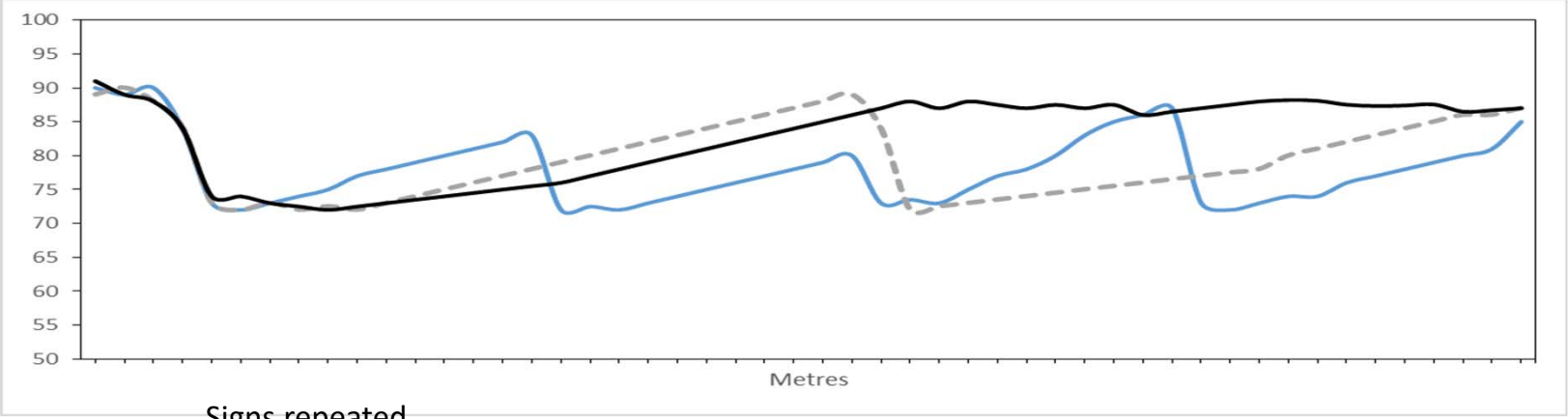
Significantly slower after driving on dashed white, $p = .004$
(as compared to wide centre line, not diff to complex)



Speed signs can have periodic effects on drivers' speeds

70 km/h Speed Limits on Former 90 km/h Roads

(Jongen, Brijs, Mollu, Brijs &Wets, 2011)



Signs repeated (every 1 km)

Special zone sign

Special zone sign repeated once

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Using road markings as a continuous cue for speed

(Charlton & Starkey, 2018)
Funded by AARF

Drivers sometimes don't notice or miss signs

Drivers do usually notice changes in lane markings

We developed road markings to indicate speed in consultation with Steering Group and NZTA

We wanted to see if speed markings would be helpful in assisting compliance self-explaining and "self-enforcing"

Method

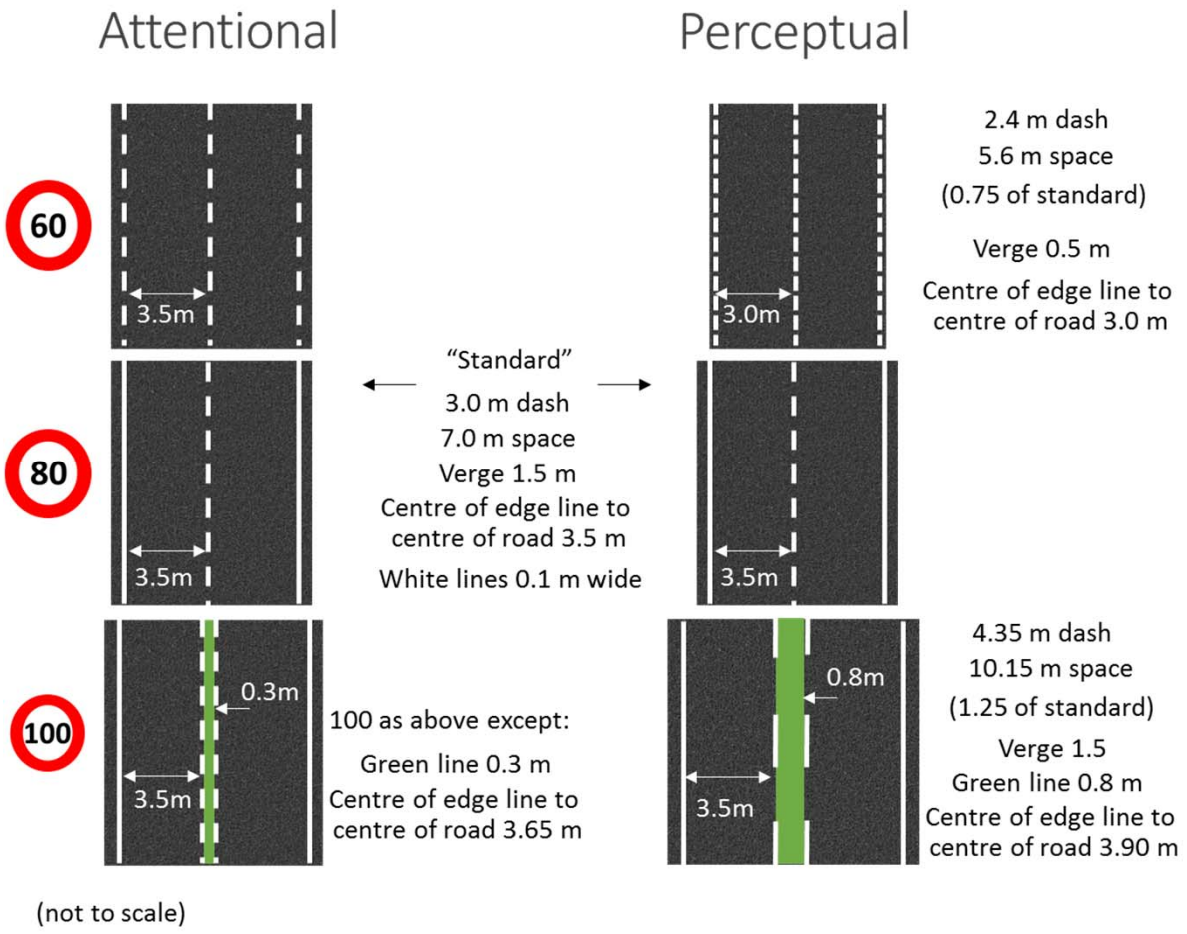
Developed two sets of road markings to indicate speed

Consultation with Steering Group and NZTA

Attentional markings based on ERC markings, adjusted for NZ rules

Perceptual markings added dash rate and lane width manipulation to ERC markings

Markings for 80 km/h used as “reference standard”



Road markings for speed delineation

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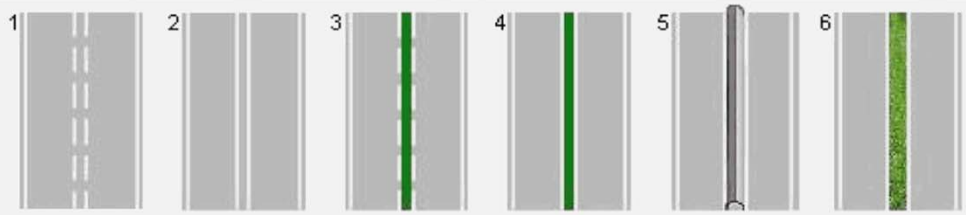
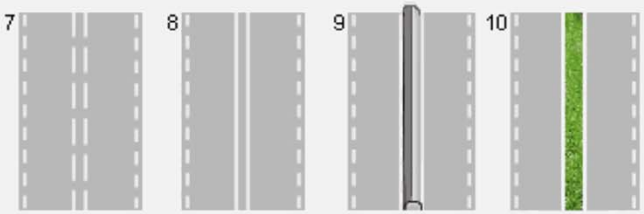
Markings based on Essential Recognisability Characteristics

Supporting drivers in forming correct expectations about transitions between rural road categories

Stelling-Konczak, Aarts, Duivenvoorden, Goldenbeld (2011)

Table 1
Examples of variants of road layout based on the 'Essential Recognisability Characteristics'.

Road type	Variants of rural road layout with Essential Recognisability Characteristics (ERCs)
Through roads (TRs)	
Distributor roads (DRs)	
Access roads (ARs)	

1 and 7 single carriageway with a broken centre line marking; 2 and 8 single carriageway with a continuous centre line marking; 3 single carriageway with a broken centre line marking filled with green; 4 single carriageway with a continuous centre line marking filled with green; 5 and 9 single carriageway with a curb; 6 and 10 single carriageway with a central reservation; 11 brick road without road marking; 12 asphalt road without marking; 13 asphalt road with side marking to the edge; 14 asphalt road with side marking towards the centre.

102 participants randomly assigned to either Attentional, Perceptual, or a Control group

55 women, 57 men

Mean age 34.07 years (range 18 – 64)

Half of the participants in Attentional and Perceptual were told about meaning of markings (Explicit group) and half were **not** told anything about the markings (Implicit group)

5 groups:

Attentional-Explicit (20), Attentional-Implicit (20)

Perceptual-Explicit (20), Perceptual-Implicit (20)

Control (22)

Two-day experiment

2 sessions, 3 days apart

Session1

Practice 80 km/h 3 km	Acquisition Road 1 10 km	Acquisition Road 2 10 km	Acquisition Road 3 10 km	Acquisition Road 4 10 km	Acquisition Road 5 10 km

Session2

Practice 80 km/h 3 km	Retention1 Road 1 10 km	Retention2 Road 3 10 km	Generalis. Road 5^X 10 km	Workload Road 2^Y 10 km	No signs-V Road 2^Z 10 km

Control

Practice 80 km/h 3 km	Acquisition Road 1 10 km	Acquisition Road 4 10 km	Acquisition Road 5 10 km	Generalis. Road 5^X 10 km	Workload Road 2^Y 10 km

Control group, single session only

Workload & No signs

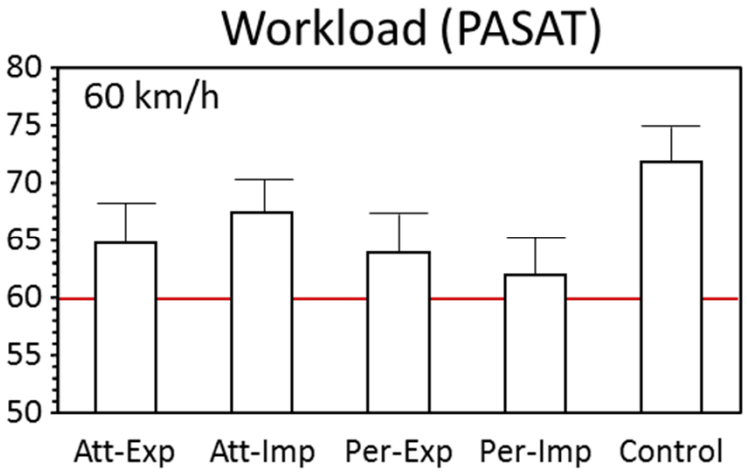
Mental workload (PASAT):

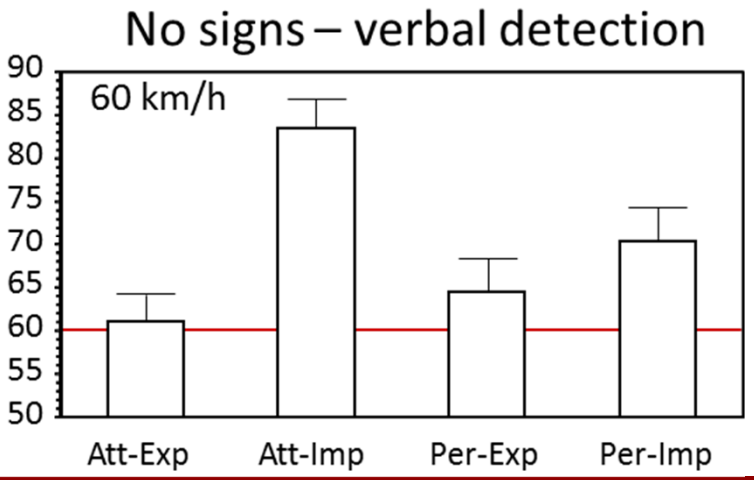
Road markings helped prevent speeding resulting from distraction

At 60 km/h Att-Exp, Per-Exp, & Per Imp all sig. lower than Control

No signs: Explicit instruction has large and significant effect

Explicit groups sig better, slight advantage for Perceptual even with no instruction



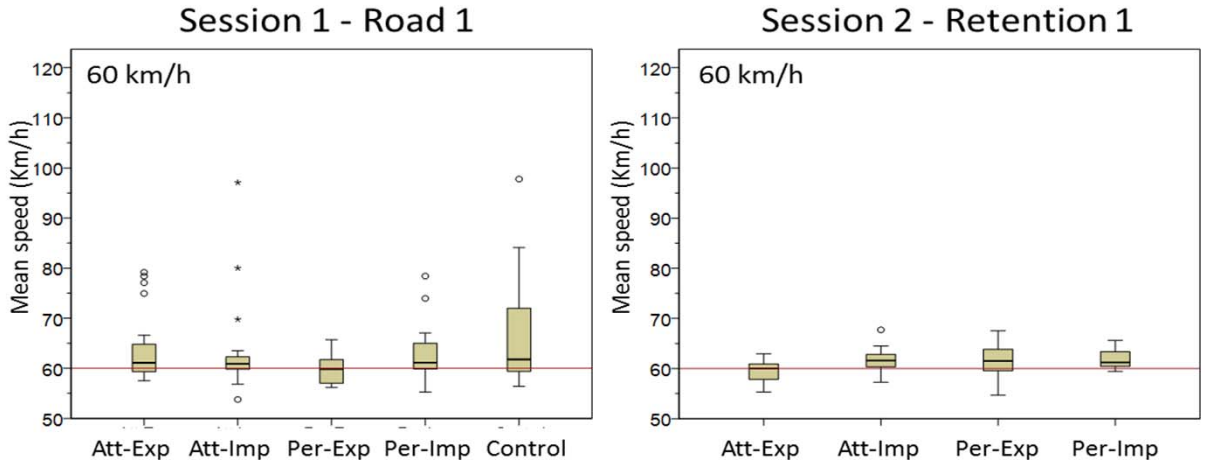


Speed homogeneity

Markings also improved homogeneity

More drivers chose the same speed for the same section of road

(Comparing the first road of Session 1, to the first road of Session 2)



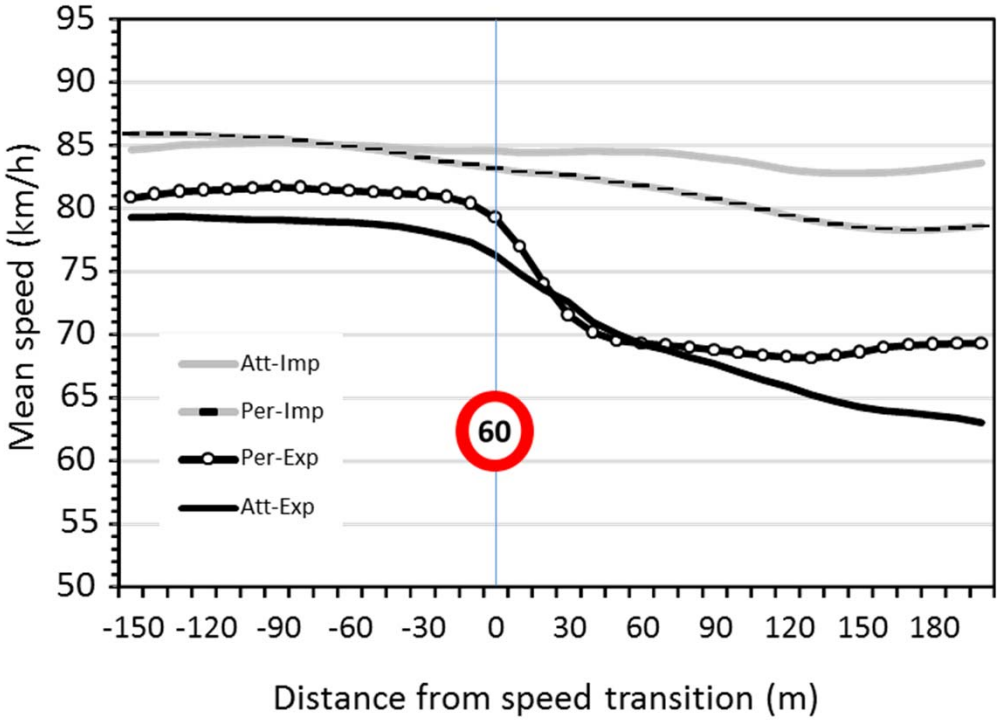
Better homogeneity leads to greater speed differentiation – clearer differences between roads with different speed limits

Speed transitions

Markings also improved transitions from one speed to another

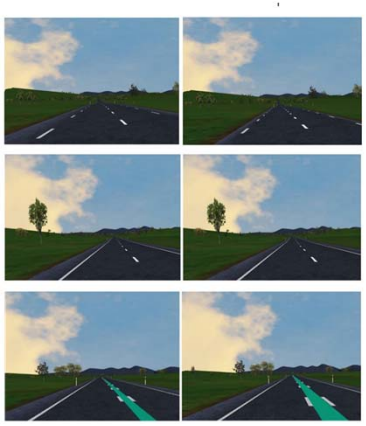
(even without speed limit signs)

but only for two explicit groups



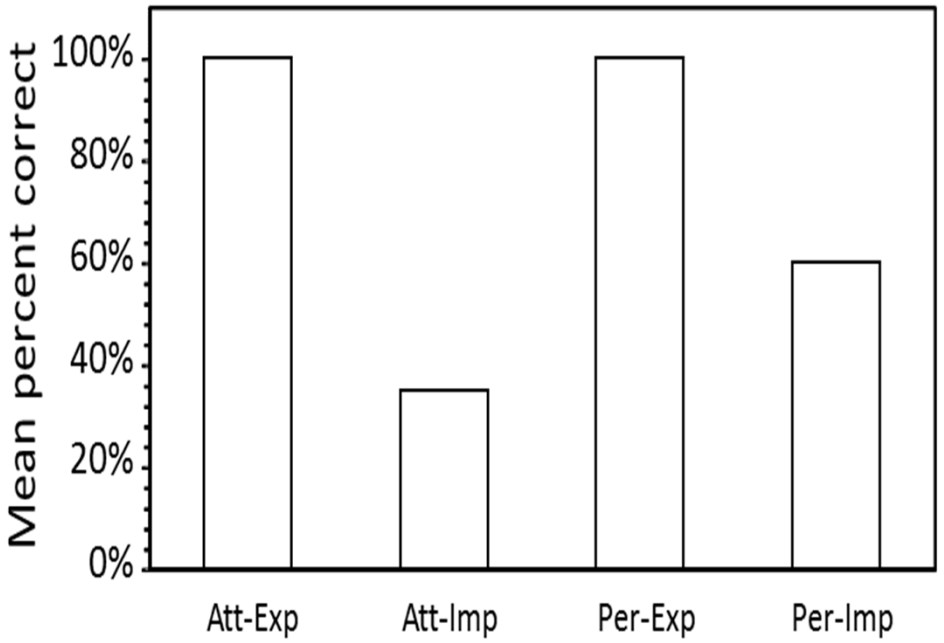
Comprehension

Comprehension score:
Percent of participants correctly identifying all 3 speed limits



- 100% of both Explicit groups
- 60% of Per-Imp correct
- Only 35% of Att-Imp ppts correct

Very limited understanding without direct instruction on meaning of markings



Produced better speed limit compliance

Produced better speed differentiation

Markings improved homogeneity

More drivers chose the same speed for the same section of road

Instructions to drivers regarding the meaning of the road markings was necessary for best performance and comprehension

What's next?

Encourage drivers to choose appropriate vehicles
(commensurate with their needs & abilities)
and make room for them!



from Trafinz approx. 10 years ago

Since then …



Can scooters, bikes and pedestrians co-exist?

Can urban road markings help?

The answer has to be *Yes*, but where?

The answers to the most interesting questions about thinking and cognitive processes are to be found in the way we perform everyday activities

(Not found in unusual laboratory tasks)

The answers to the most interesting questions about driving are to be found in the way we all drive, every day

(Not found in extreme people or situations)

Questions

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