

# Using road markings in innovative ways

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# Road markings

Where did they come from?

What are they for?



Roads haven't changed much since 450BC  
*(some of them are still in use)*

### The Roman road hierarchy

Viae – through roads



Viae rusticae  
secondary roads



Viae vicinales  
local roads



What roads did not have,  
was lane markings on their surface



Paris



London



New York



Edward Hines, director of the Wayne County Board of Roads, had a white centre line painted in the town of Trenton, Michigan in 1911. He apparently got the idea after seeing a milk truck leak some of its product on the road.



Dr June McCarroll, a California physician personally painted the first known stripe in California in 1917 -- after surviving a near-collision in her Model T Ford on Indio Boulevard, then part of US99

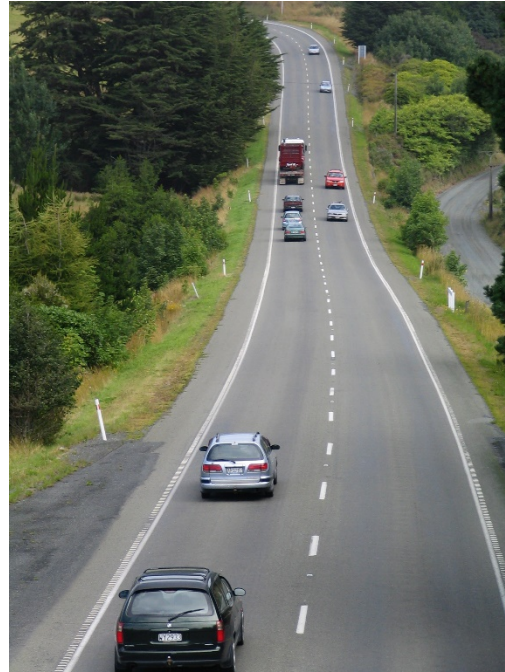


Kenneth I. Sawyer, road commissioner for Marquette county MI had a white line painted at Dead Man's Curve in 1917 -- between Marquette and Negaunee MI

Painting a centre white line in the UK was experimented with in 1921 in Birmingham, following complaints by residents over reckless driving and several collisions, the Sutton Coldfield Corporation decided to paint the line on Maney Corner.

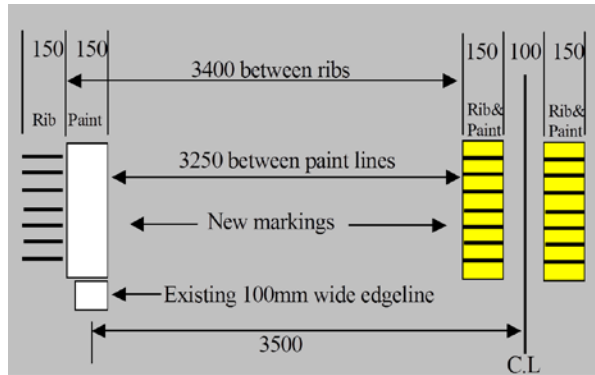
# Why?

## Lines function as guidance cues



# Lines function as guidance cues

## South Waikato & Taupo Target 2010 Project



(Charlton, 2006)

Significant safety gain  
with no increase in speed



Before



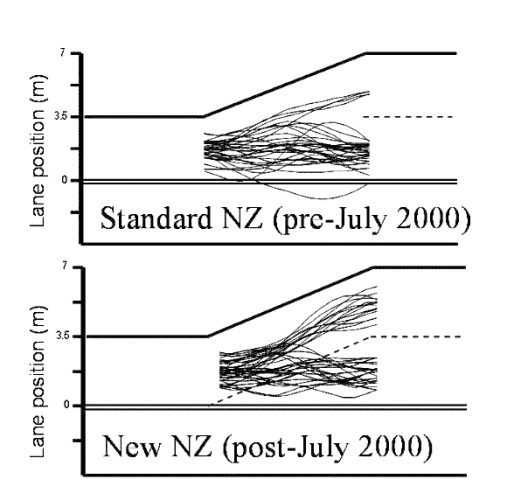
After



# 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 also function as permission cues



# Lines also function as permission cues

Keeping drivers safely separated  
(and narrowing the lanes)



Lines can alert us to unseen hazards ahead



Lines can alert us to unseen hazards ahead



# 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



# What road markings will most quickly prepare drivers for the hazards associated with 2\* rural roads? (in this case a 55 km/h curve)

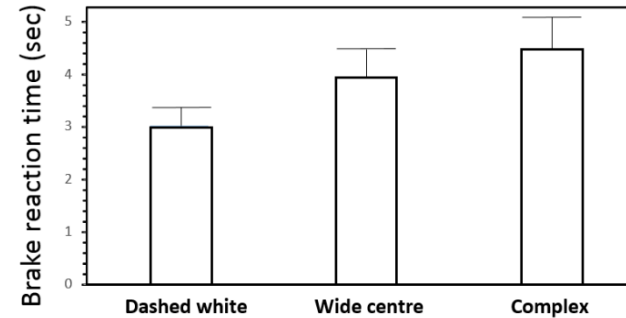
50 fully licenced drivers (28 female) completed the experiment  
Mean age was 36.58 years (SD = 13.95, range 16 – 64 years)

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,  $p < .001$ )



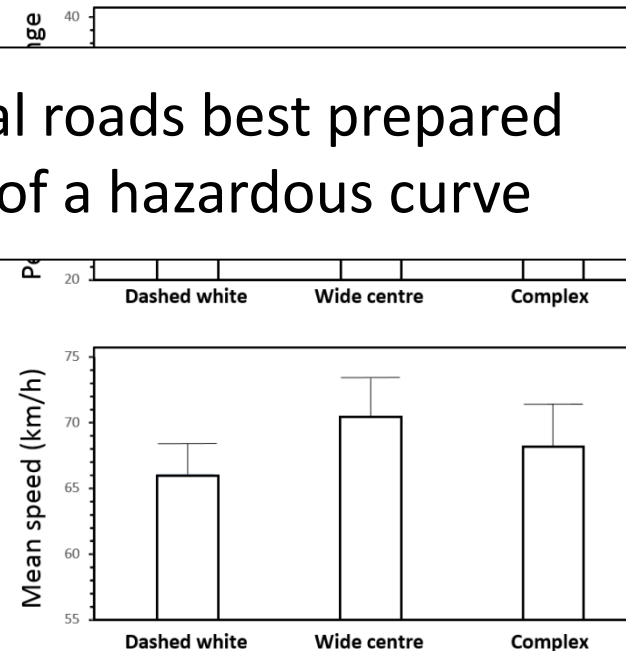
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Immediate change to 2\* rural roads best prepared drivers for the appearance of a hazardous curve

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)



# Lines function as risk cues

## Perceived risk, speed, & countermeasures

(Charlton & Starkey, 2016)

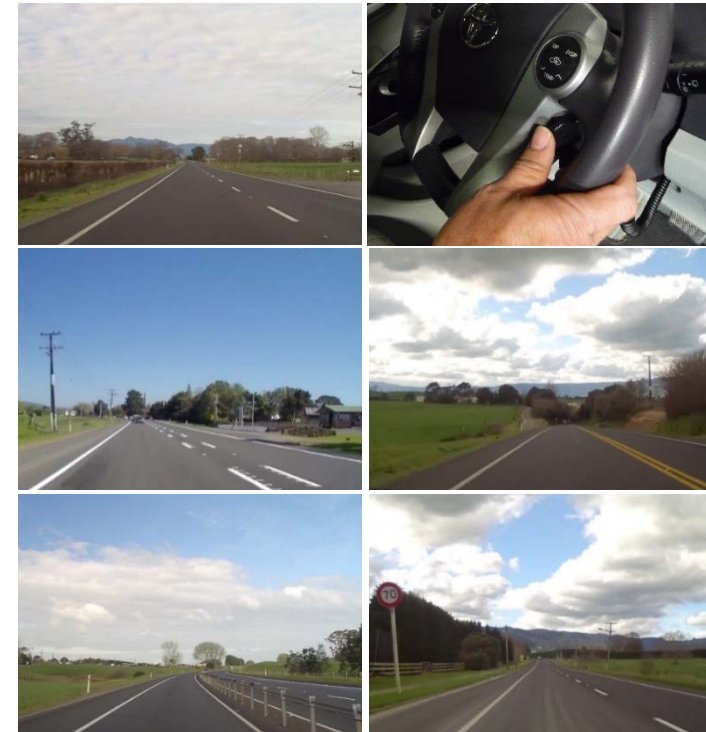
Funded by the AARF

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

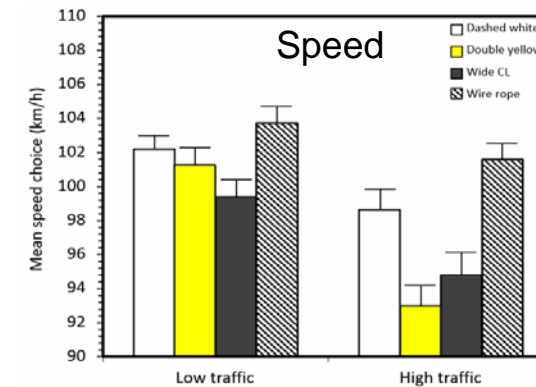
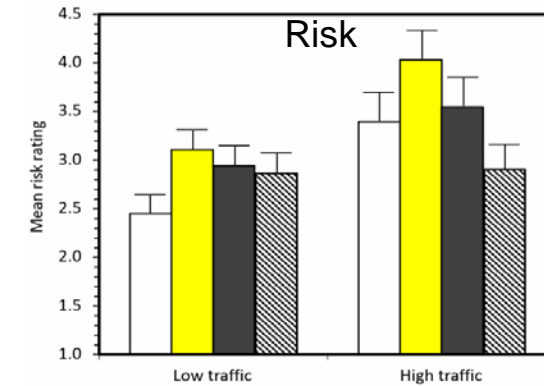


These effects were most pronounced for double yellow centre lines

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



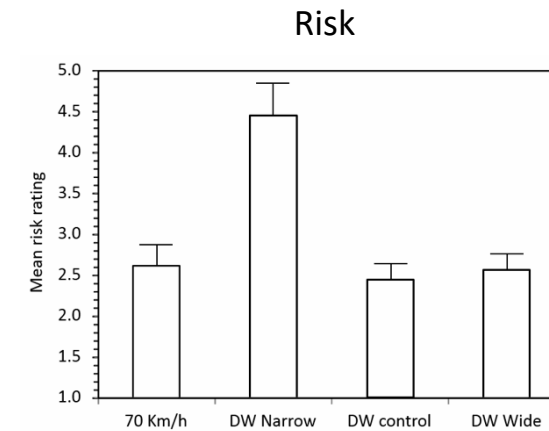
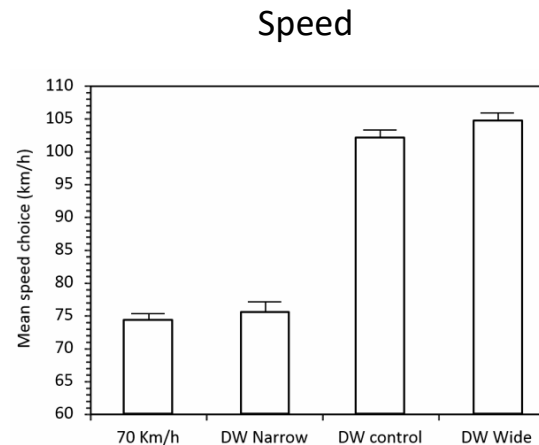
Wire rope barriers minimised the risk effect of high traffic



# The effect of road width

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



# Colour coding risk & speed?

Daniel Campagne, 2005

Universidad Nacional de Educacion a Distancia Madrid



Figure 3:  
Urban area road  
colour coded for  
low speed



Figure 4:  
Country road  
coded for  
intermediate  
speed

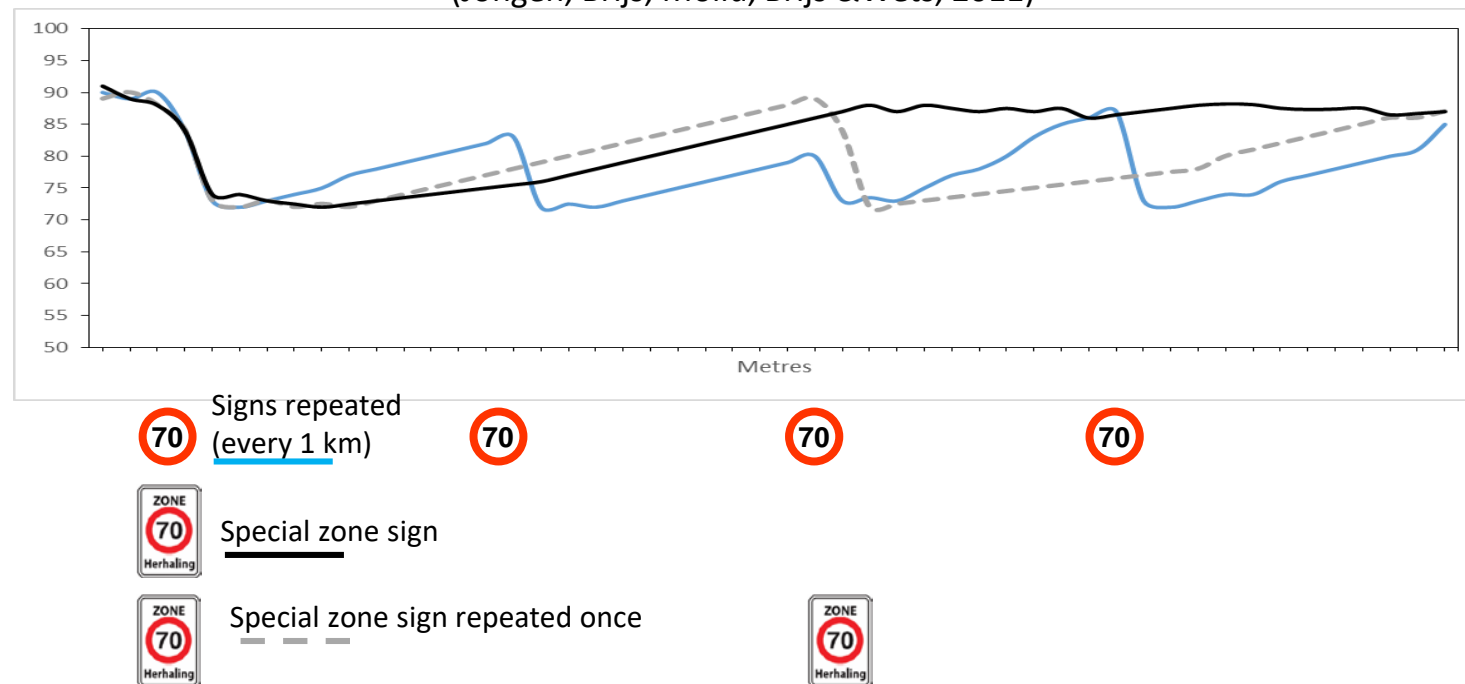


Figure 5:  
Motorway colour  
coded for high  
speed

# 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)



# 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

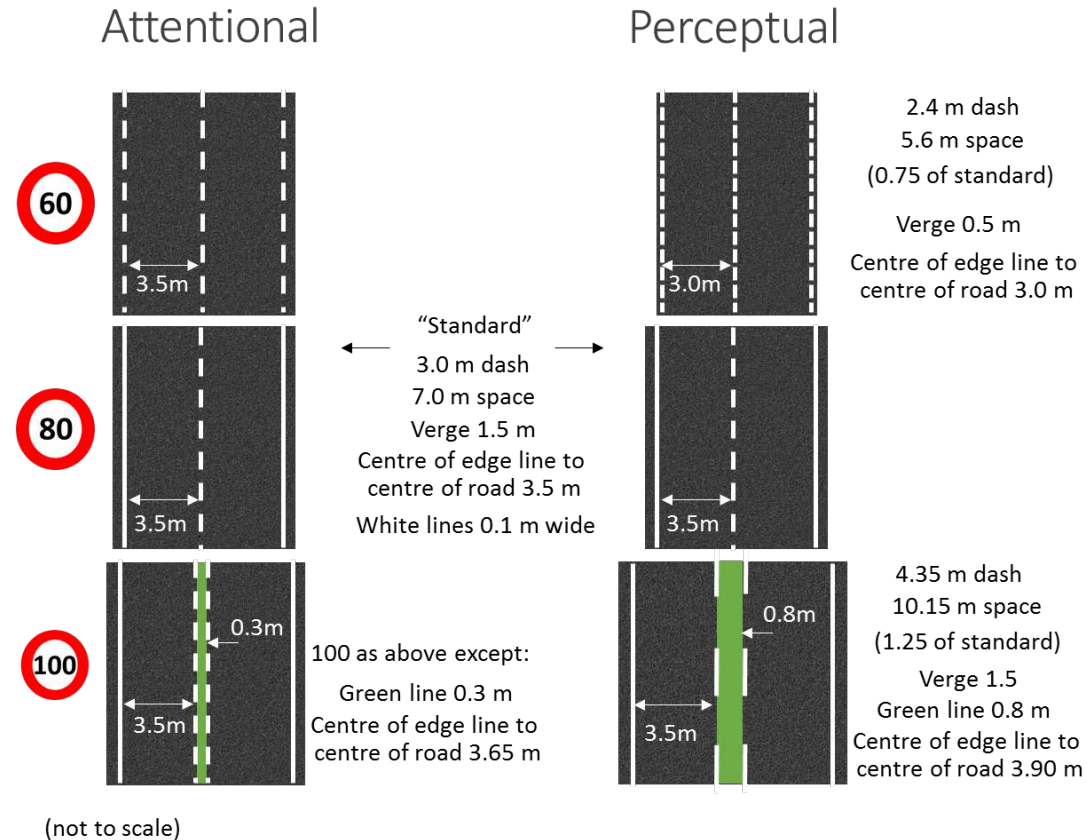
Developed two sets of road markings to indicate speed

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



# 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)	1	2	3	4	5	6
Distributor roads (DRs)	7	8	9	10		
Access roads (ARs)	11	12	13	14		

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)

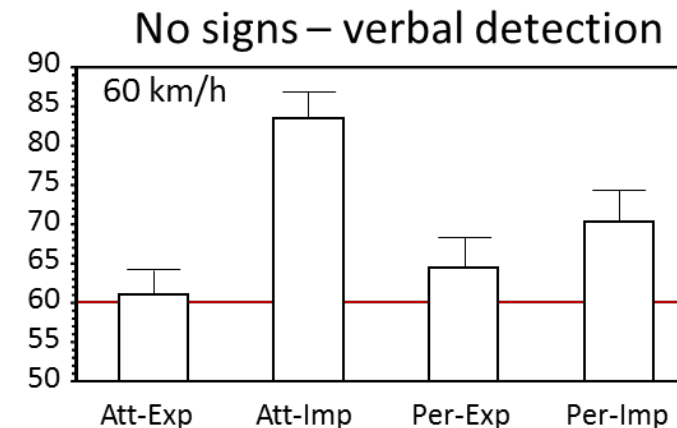
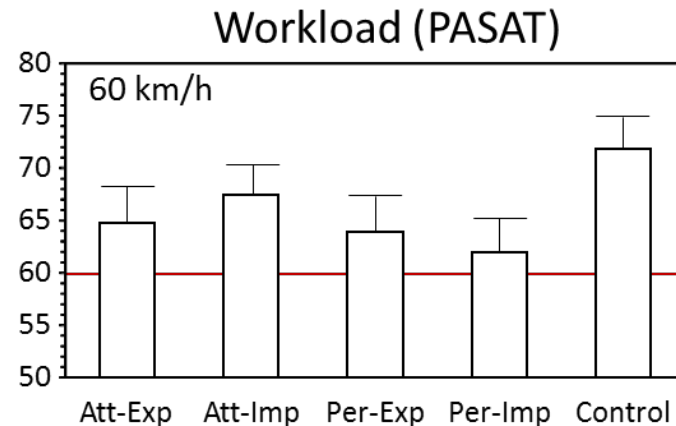


# Workload & No signs

Mental workload (PASAT):  
Road markings helped prevent  
speeding resulting from  
distraction. Att-Exp, Per-Exp, & Per Imp all  
sig. lower than Control

No signs: Explicit instruction has  
large and significant effect

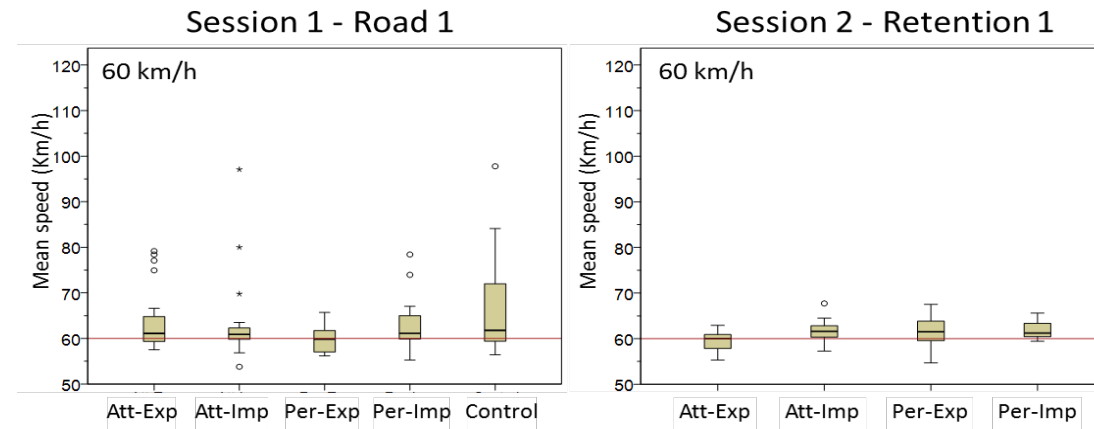
Explicit groups sig better, slight advantage  
for Perceptual even with no instruction



# Speed homogeneity

## Markings also improved homogeneity

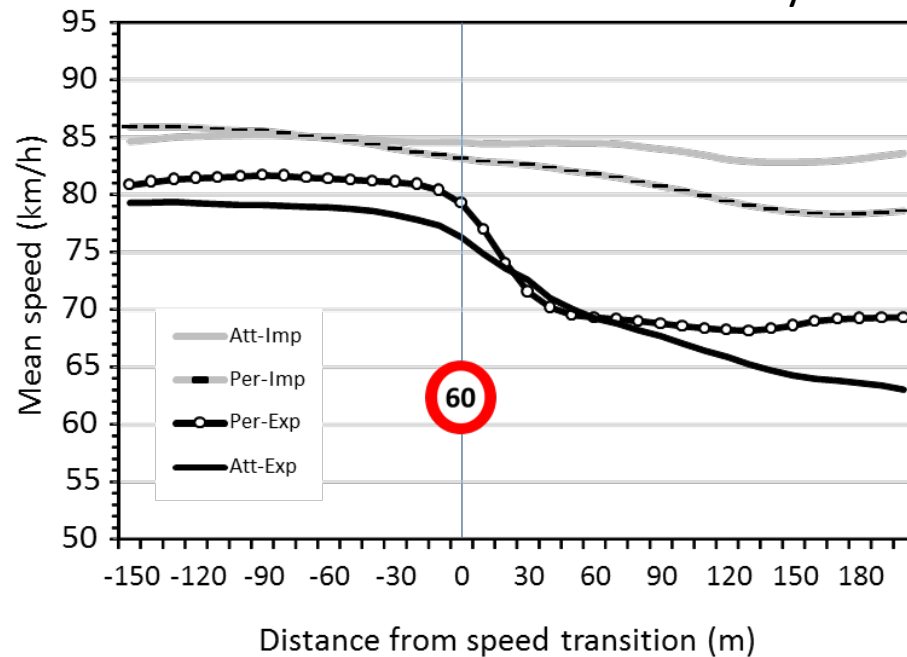
More drivers chose the same speed for the same section of road  
(Comparing the first road of Session 1, to the first road of Session 2)



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

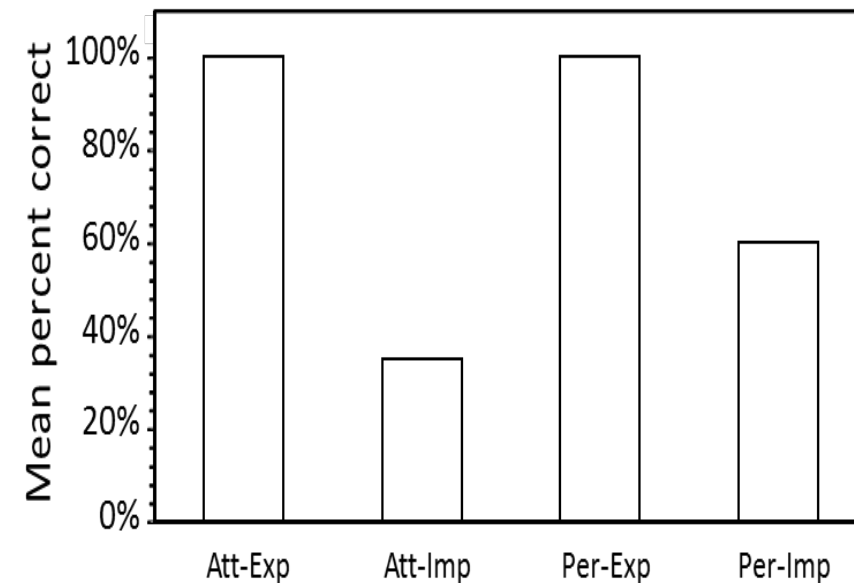
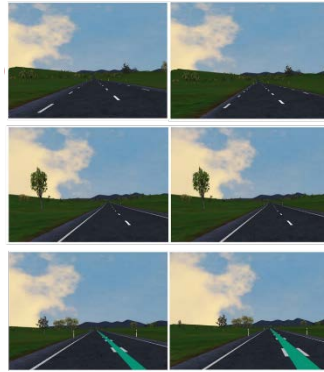


# Comprehension

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



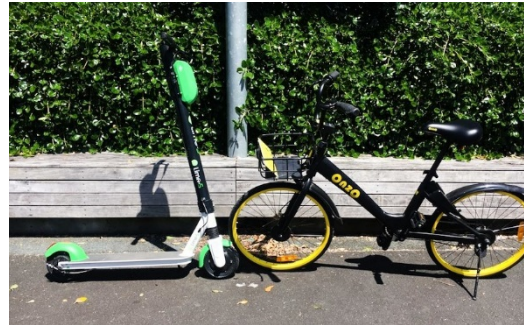
Instructions to drivers regarding the meaning of  
the road markings was necessary for best  
performance and comprehension

# What's next?

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



Since then ...





Can scooters, bikes and pedestrians co-exist?



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



# Road markings: Where did they come from? What are they for?

Original idea apparently came from spilled milk and used to provide explicit guidance to drivers



Road markings also convey permission cues, and can serve as hazard warnings



We use road markings to form mental schemata about what lies ahead, and could be used consistently to indicate speed

Road markings are the least expensive of road safety interventions, and may have promise for our future problems

# Questions