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Hibberd, DL, Jamson, AH, Jamson, SL et al. (1 more author) Designing an in-vehicle eco-driving support system to assist drivers in conserving fuel. In: Annual Meeting of the Human Factors and Ergonomics Society Europe Chapter, 16-18 Oct 2013, Turin, Italy. (Unpublished)

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# Designing an in-vehicle eco-driving support system to assist drivers in conserving fuel

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Institute for Transport Studies  
Uni. Leeds

HFES 2013



Co-financed by



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[www.ecodriver-project.eu](http://www.ecodriver-project.eu)

# What is eco-driving?

## GOLDEN RULES

MAINTENANCE



MODE AND VEHICLE CHOICE

# Real-time, in-trip, feed-forward

Anticipate  
traffic flow

Maintain a steady  
speed at low RPM

Shift up early  
**Fuel efficient acceleration and deceleration**  
Avoid excessive  
braking

Make use of engine  
braking

Check tyre pressures

Do not carry unnecessary loads

# Key questions

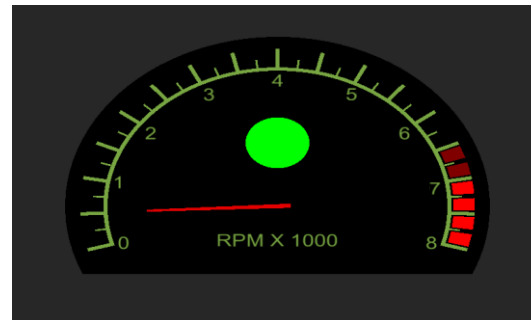
- Do drivers want eco-driving assistance?



- What in-trip assistance is best?
- What in-trip assistance do drivers prefer?

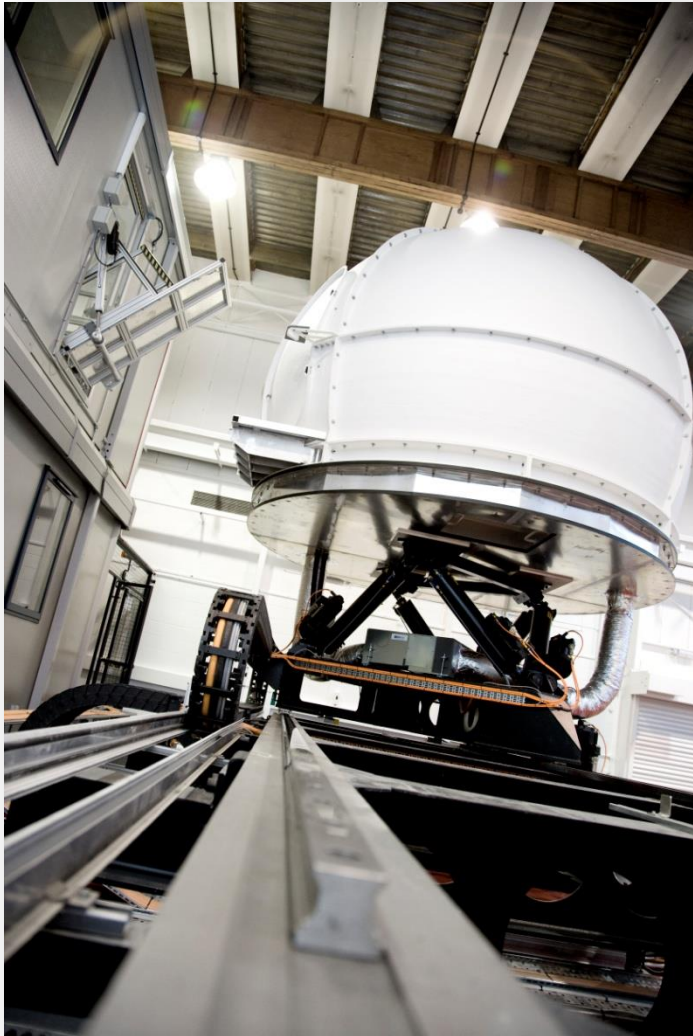
# Previous work

- Rapid prototyping study
- 6 visual/auditory
- 6 haptic





# University of Leeds Driving Simulator



# Eco-driving Scenarios

Village Entry



Village Centre



Village Exit



Bend Entry



Bend Navigation



Bend Exit



S-Bend Entry



S-Bend Navigation



S-Bend Exit

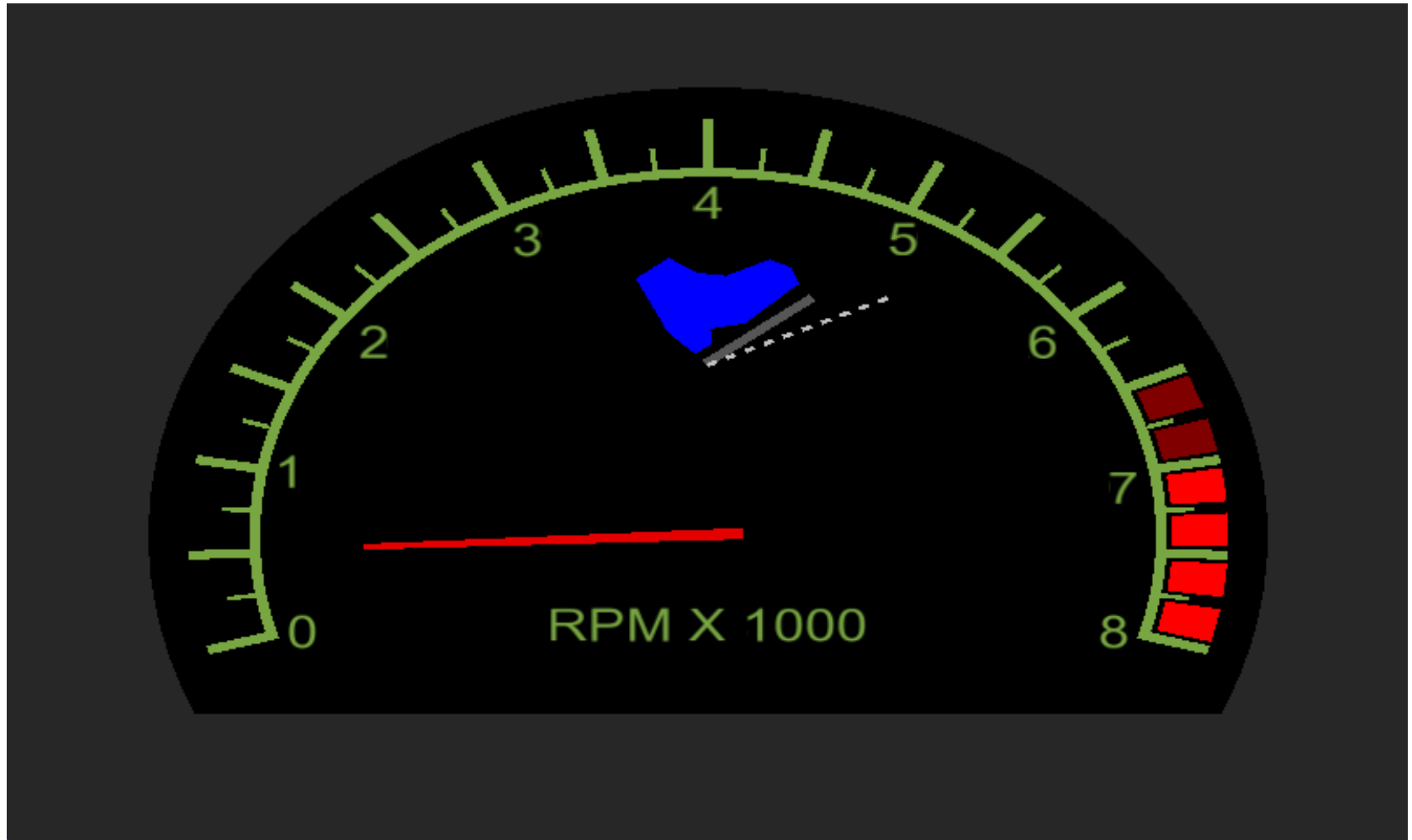




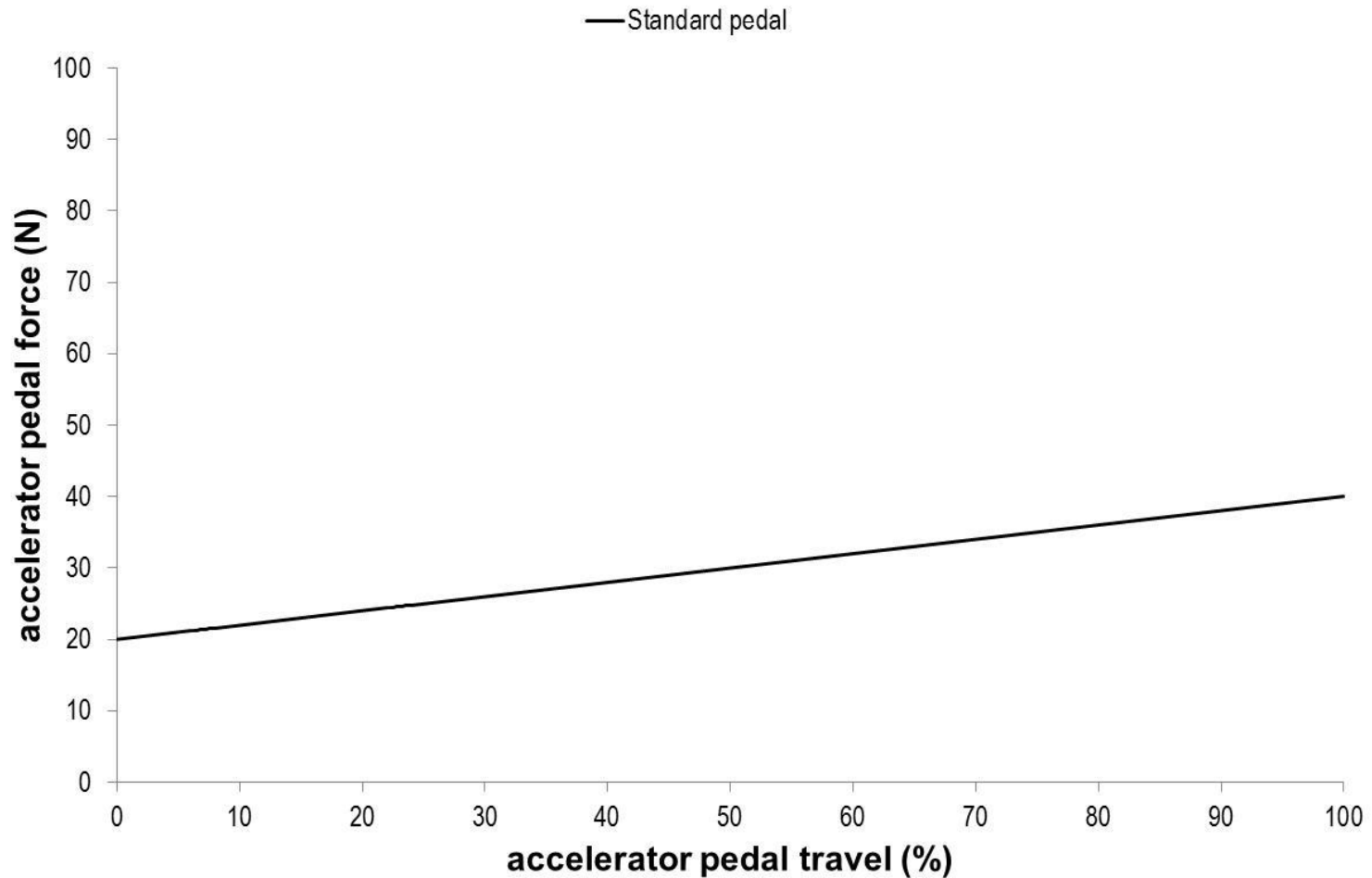
# Study Design

- **In-vehicle feed-forward advice**
- HMI modality study
  - Visual via glass dashboard
  - Haptic via 0-200N variable pedal
- **Feedback and Advice Strategy (FAS):**  
guiding drivers to **correct throttle angle**
- **Simple eco-driving algorithm**

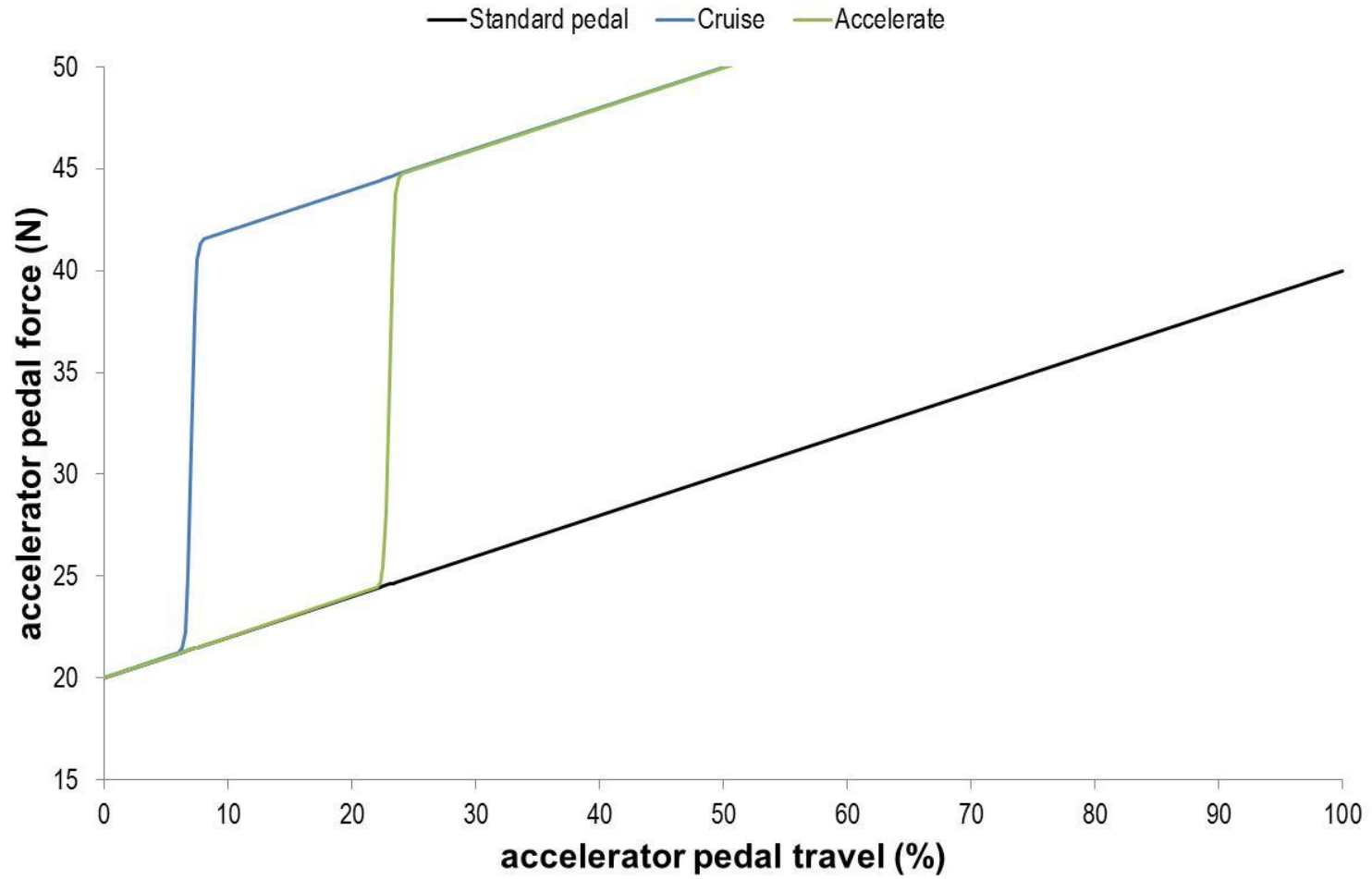
# Visual display: *Eco-foot*



# Haptic pedal: *Normal*



# Haptic pedal: *Force system*

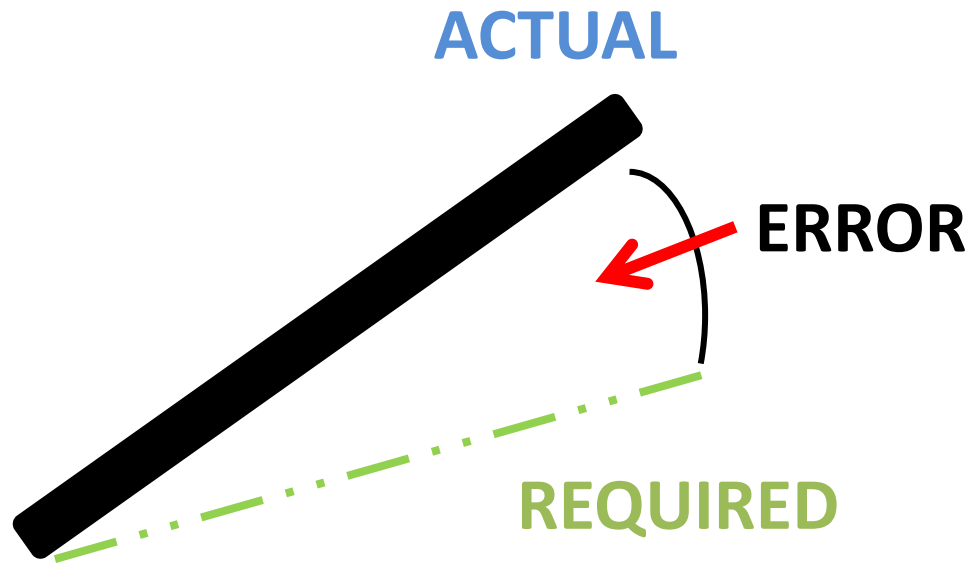


# Haptic pedal: *Stiffness system*





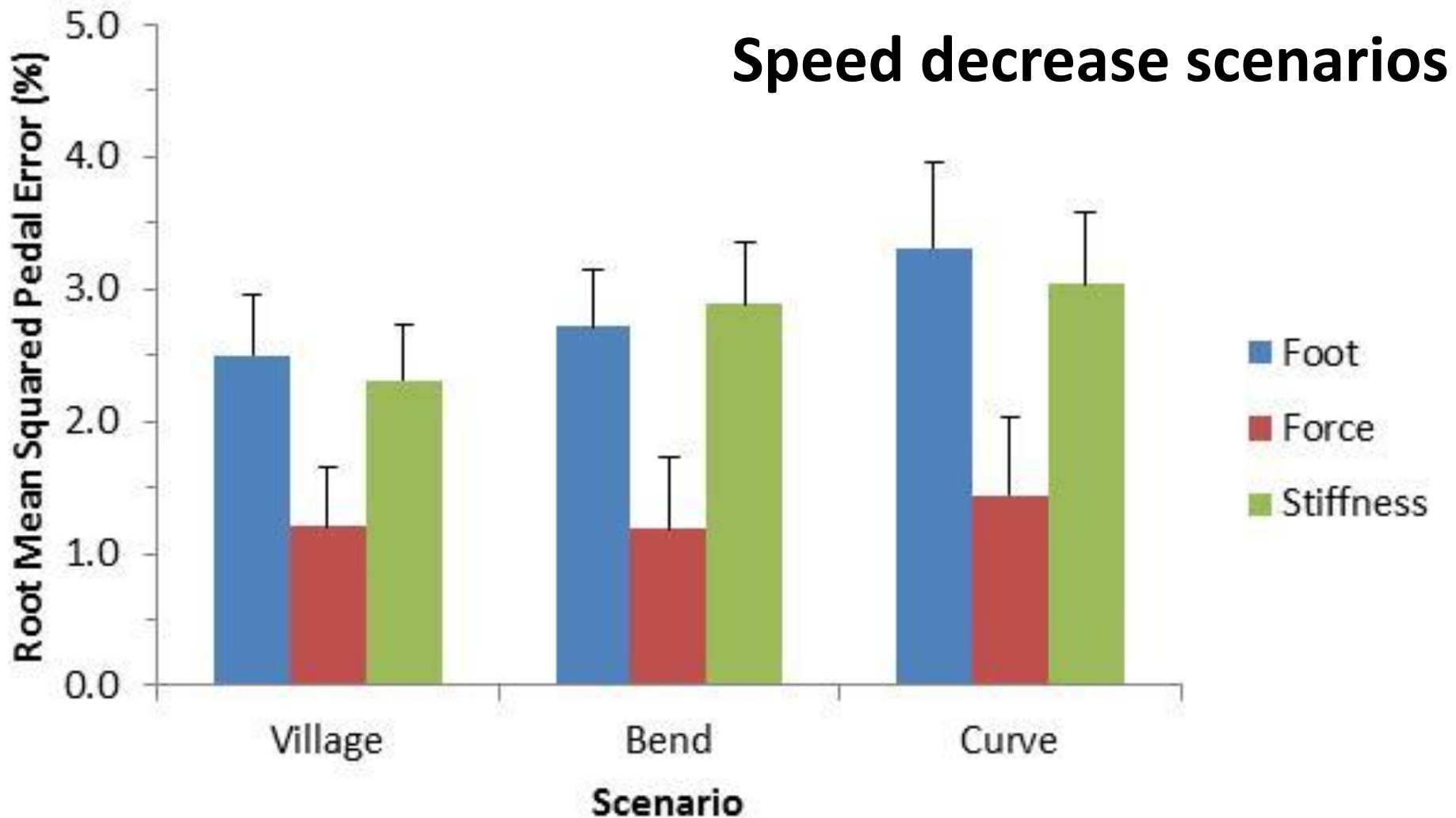
# Measures



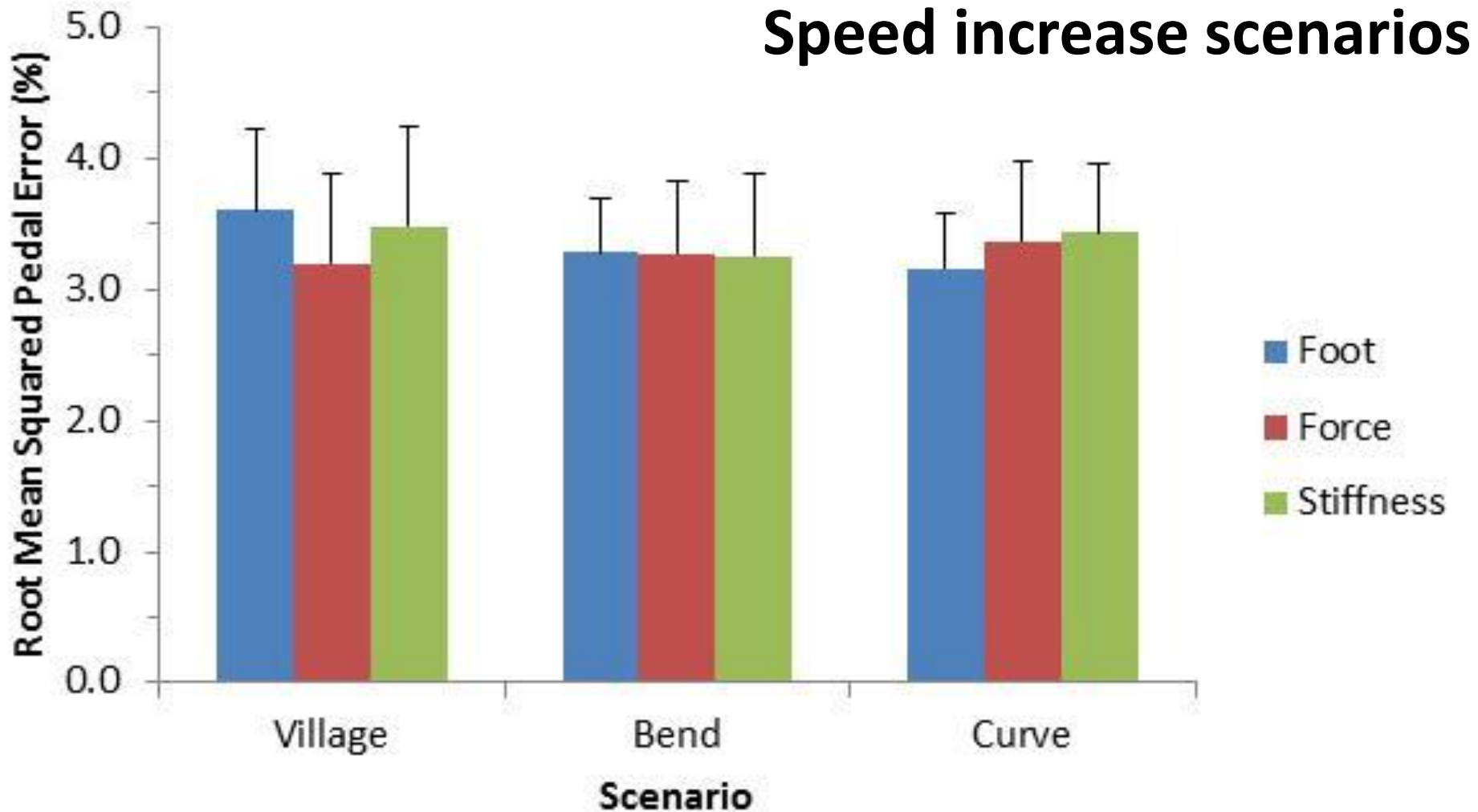
*Root mean squared pedal error*



# Results – Pedal Error

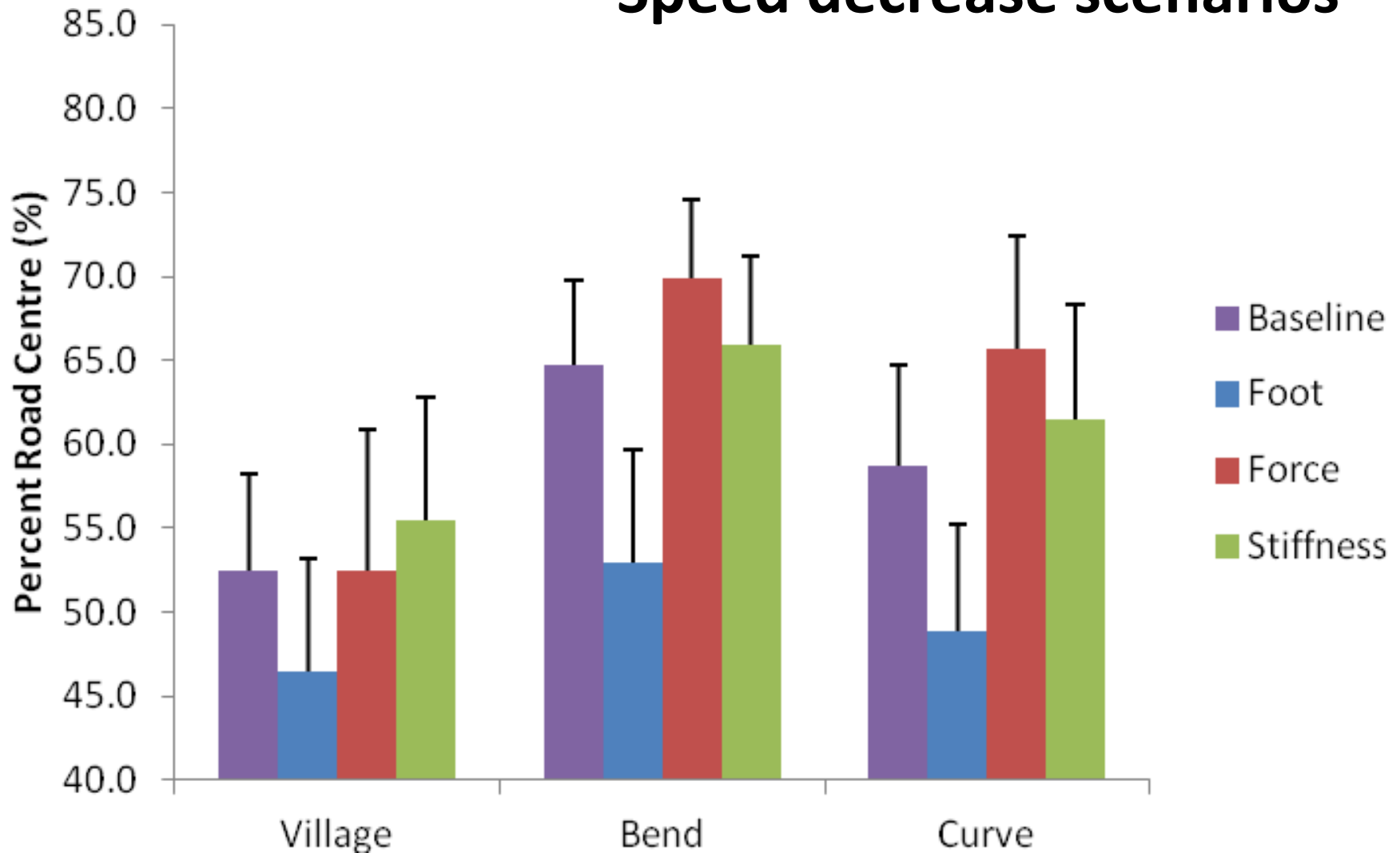


# Pedal Error

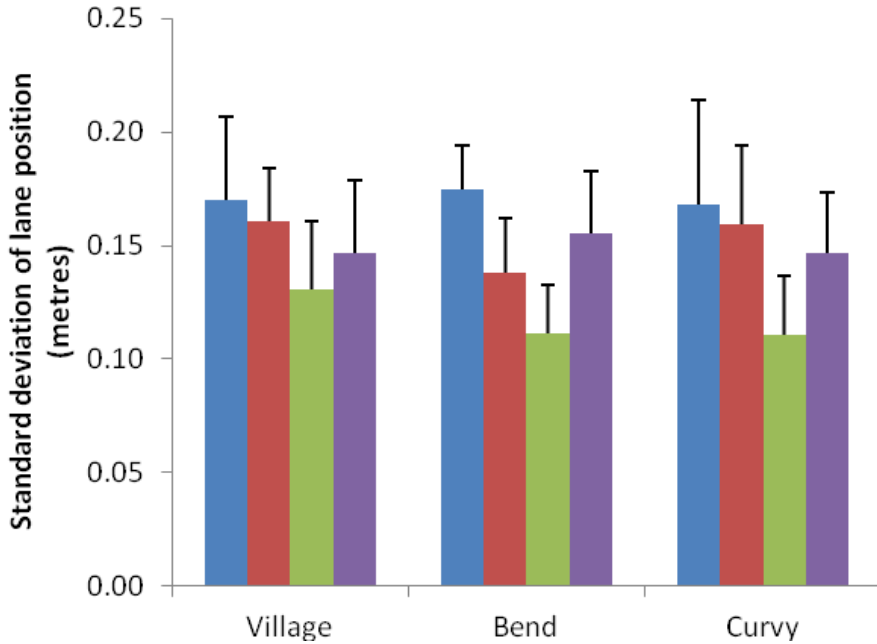


# Percent Road Centre

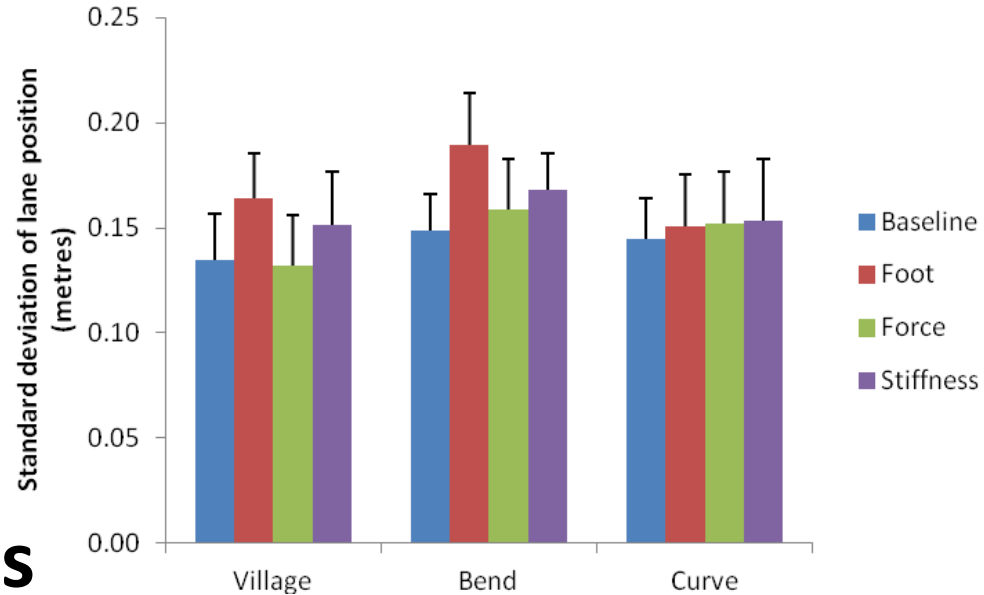
## Speed decrease scenarios



# SDLP



## Speed decrease scenarios



## Speed increase scenarios



# Workload: NASA-TLX

25.0

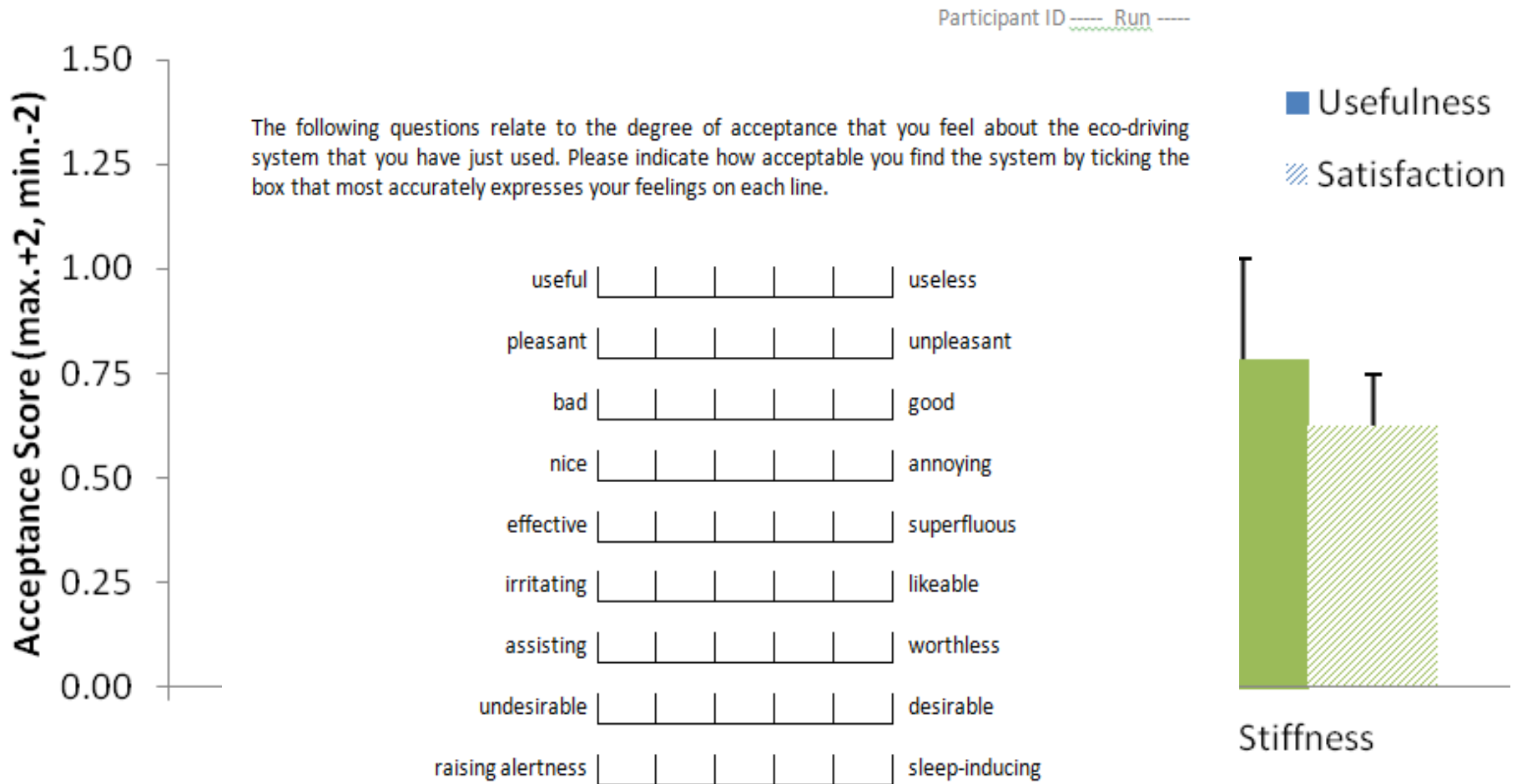
Rate how demanding you found the task of reaching and maintained the posted speed limit in the most fuel efficient way (with the ecode driving system if one is present). Please mark a vertical line on each scale. Definitions are included for each scale heading.

Title	RATING SCALE DEFINITIONS	
	Endpoints	Descriptions
MENTAL DEMAND	Low/High	How much mental and perceptual activity was required (e.g. thinking, deciding, calculating, remembering, looking, searching etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?
PHYSICAL DEMAND	Low/High	How much physical activity was required (e.g. pushing, pulling, turning, controlling, activating etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or labourious?
TEMPORAL DEMAND	Low/High	How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?
PERFORMANCE	Good/Poor	How successful do you think you were in accomplishing the goals of the task set by the experimenter? How satisfied were you with your performance in accomplishing these goals?
EFFORT	Low/High	How hard did you have to work (mentally and physically) to accomplish your level of performance?
FRUSTRATION LEVEL	Low/High	How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?



Participant ID ----- Run -----

# Acceptance: *Van der Laan*



# Discussion

- Haptic force as a potentially useful in-trip guidance modality
- Specific to speed decrease scenarios?
- Need for objective-subjective balance
- Solve “MPG or L/100KMdisputes”



# Thank you



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