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

Daryl Hibberd, Hamish Jamson, Samantha Jamson, Natasha Merat

Institute for Transport Studies
Uni. Leeds

HFES 2013

Co-financed by

SEVENTH FRAMEWORK PROGRAMME

www.ecodriver-project.eu

UNIVERSITY OF LEEDS
DRIVING SIMULATOR
INVESTIGATING DRIVER BEHAVIOUR IN A SAFE AND CONTROLLABLE RESEARCH ENVIRONMENT

ecoDriver

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

Avoid excessive braking

Shift up early

Fuel efficient acceleration and deceleration

Make use of engine braking

Check tyre pressures

Do not carry unnecessary loads

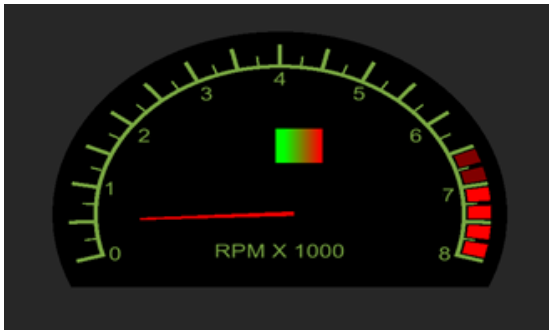
Key questions

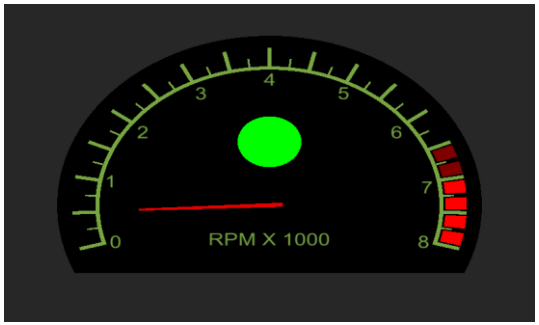
- Do drivers want eco-driving assistance?

- 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

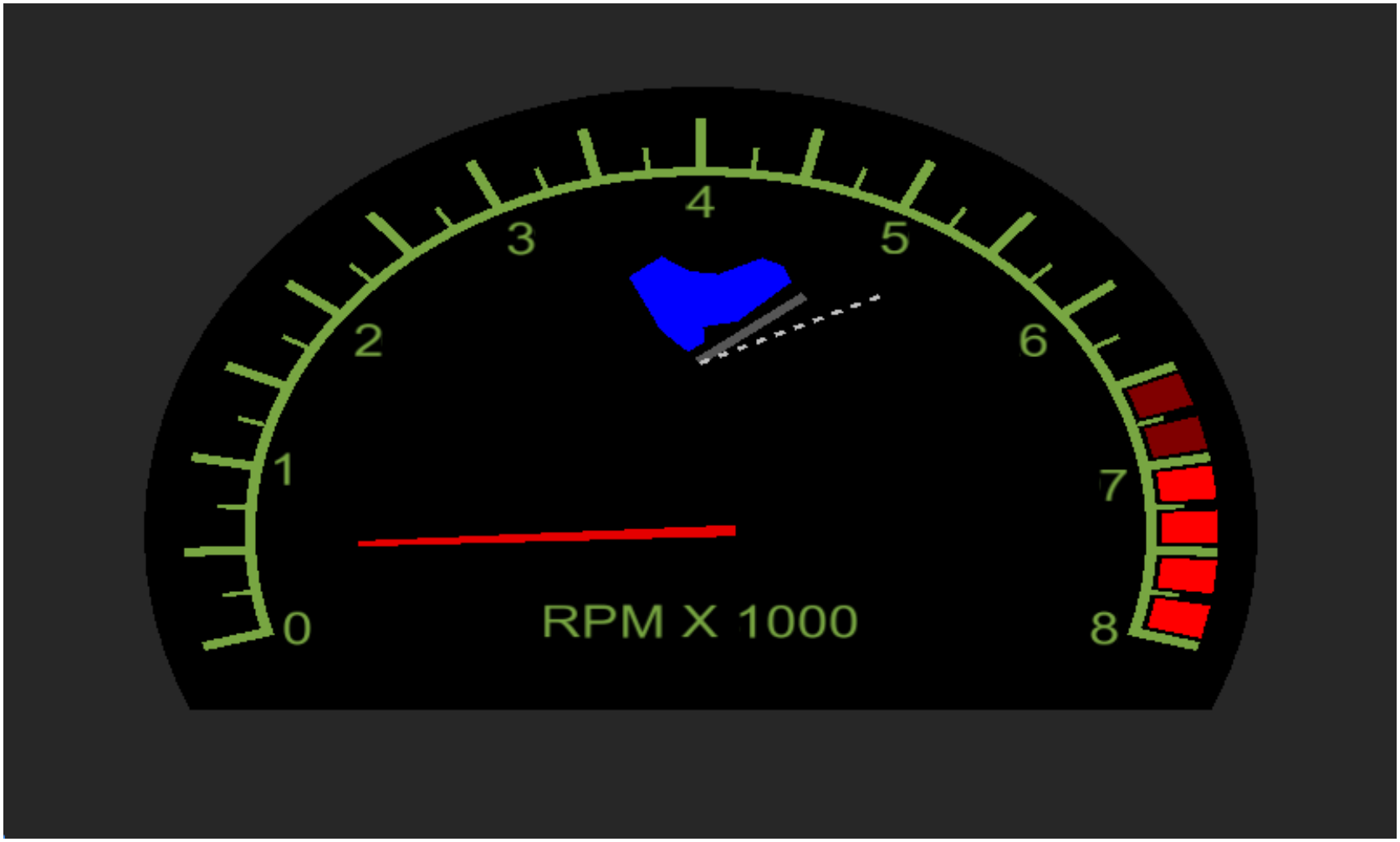
S-Bend Navigation

S-Bend Exit

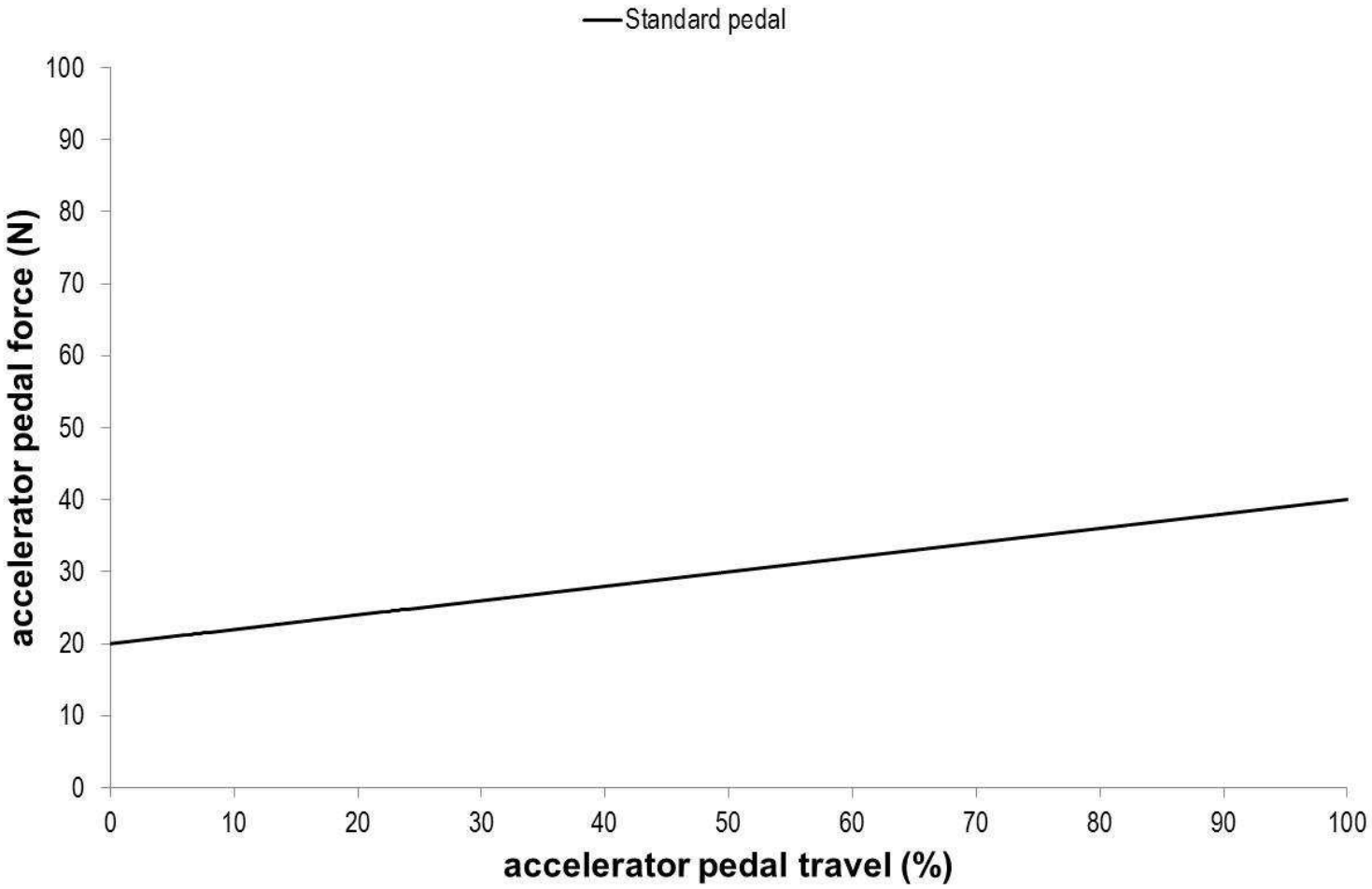
Study Design

- **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**

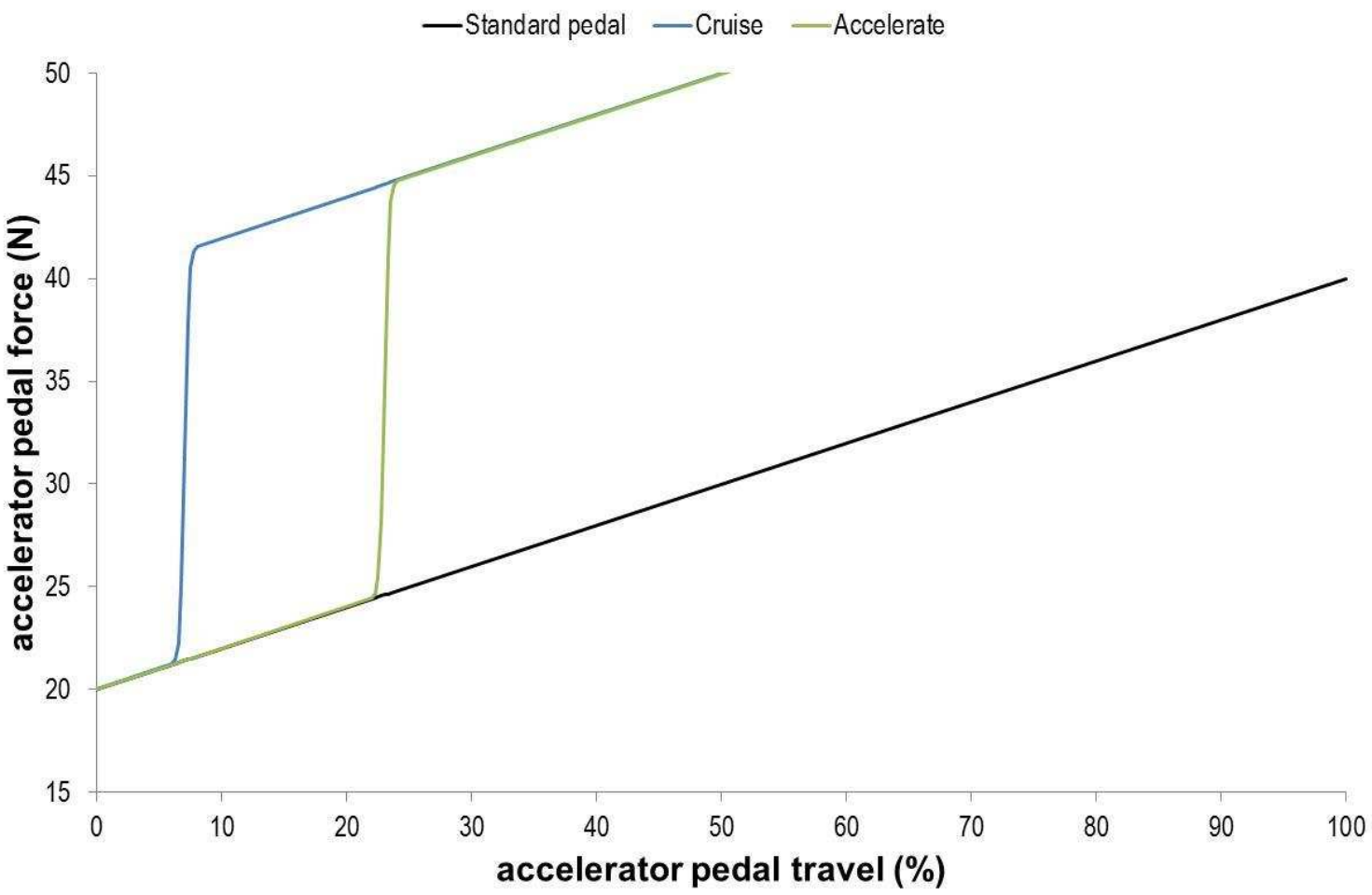
Visual display: *Eco-foot*



Haptic pedal: *Normal*

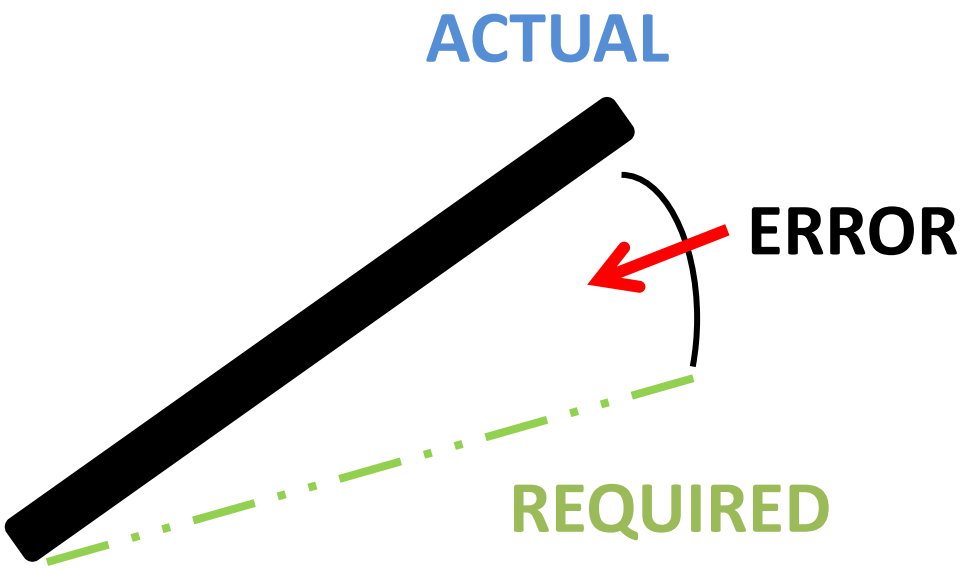


Haptic pedal: *Force system*



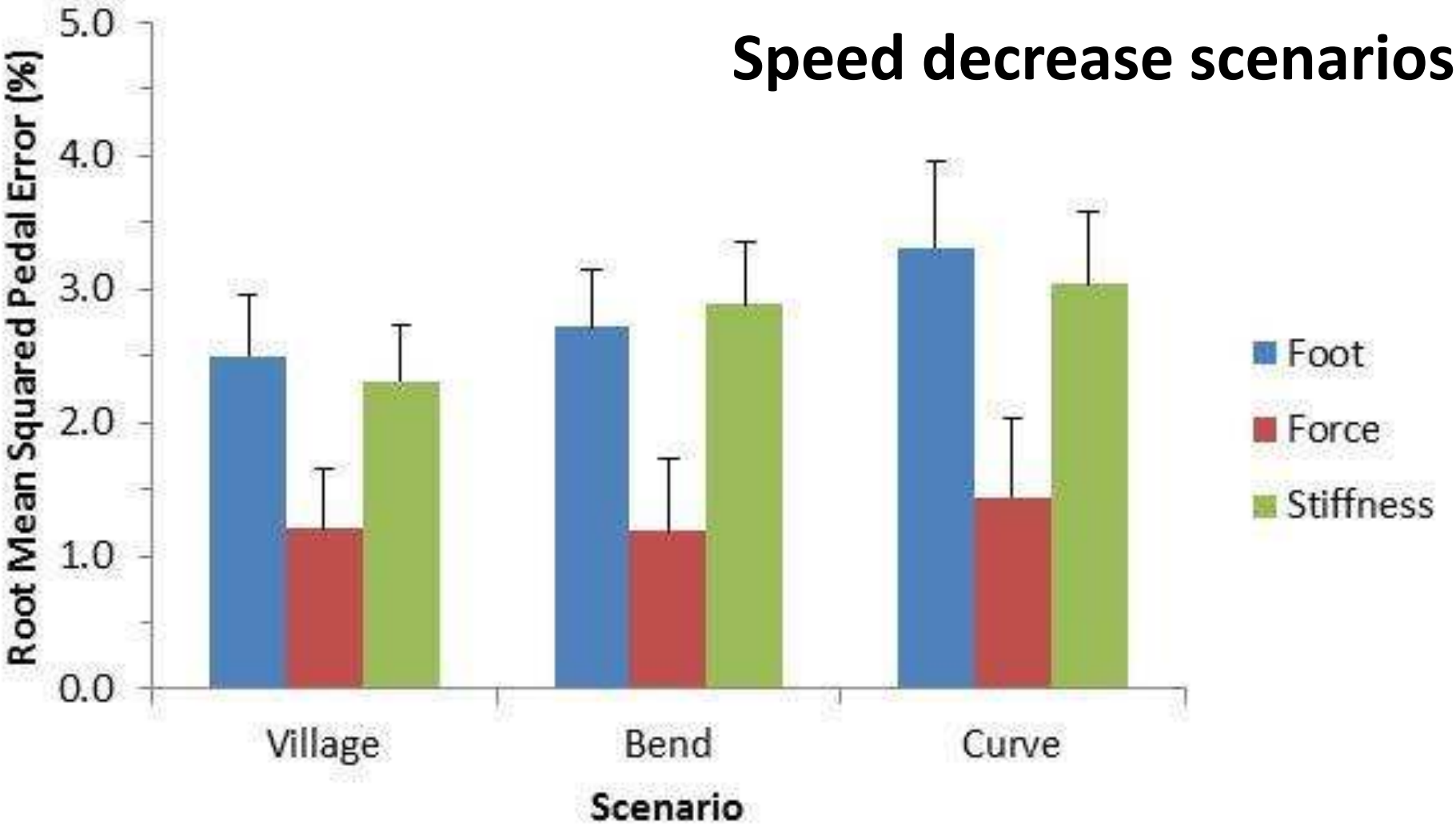
Haptic pedal: *Stiffness system*

Measures



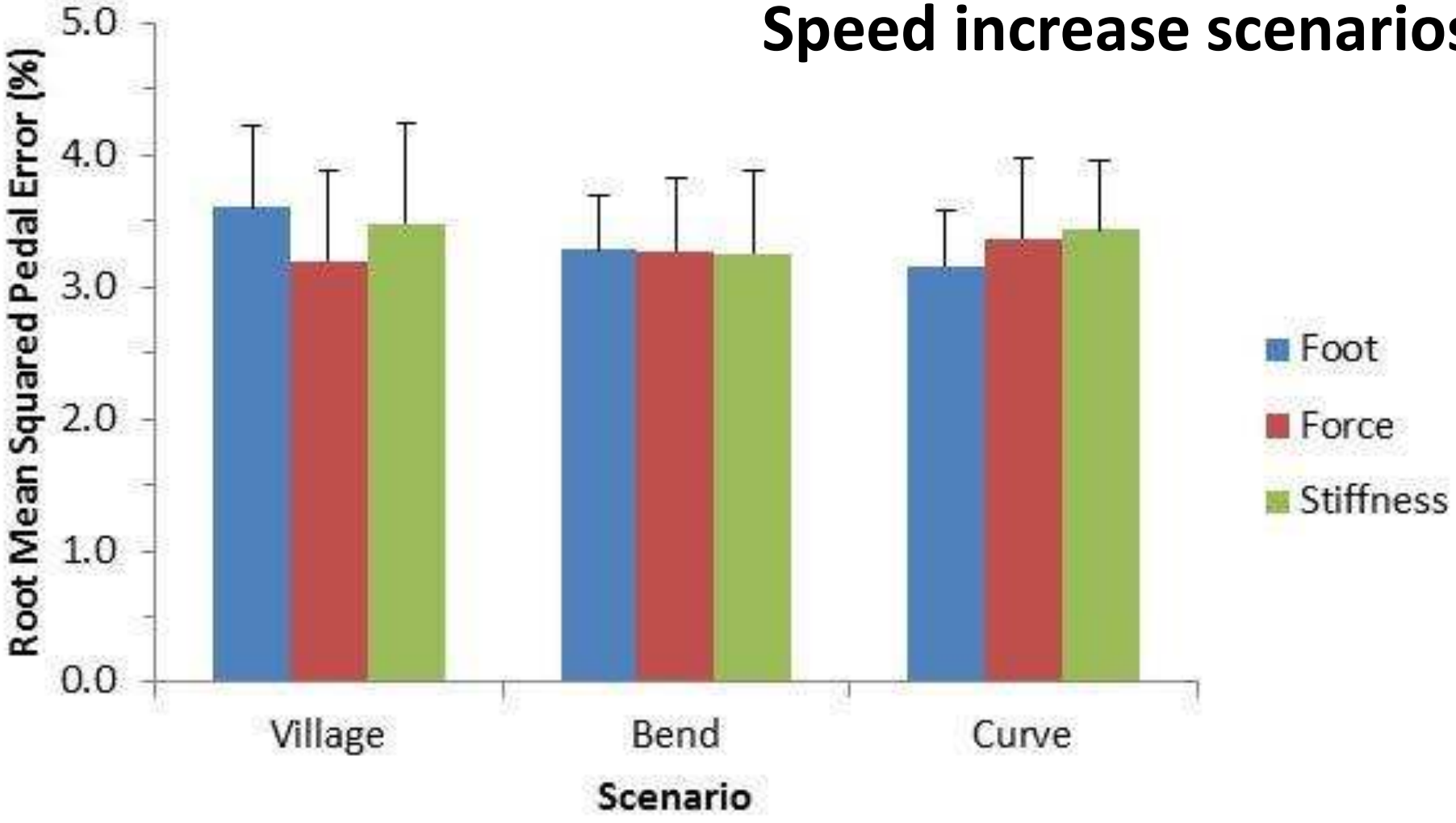
Root mean squared pedal error

Results – Pedal Error

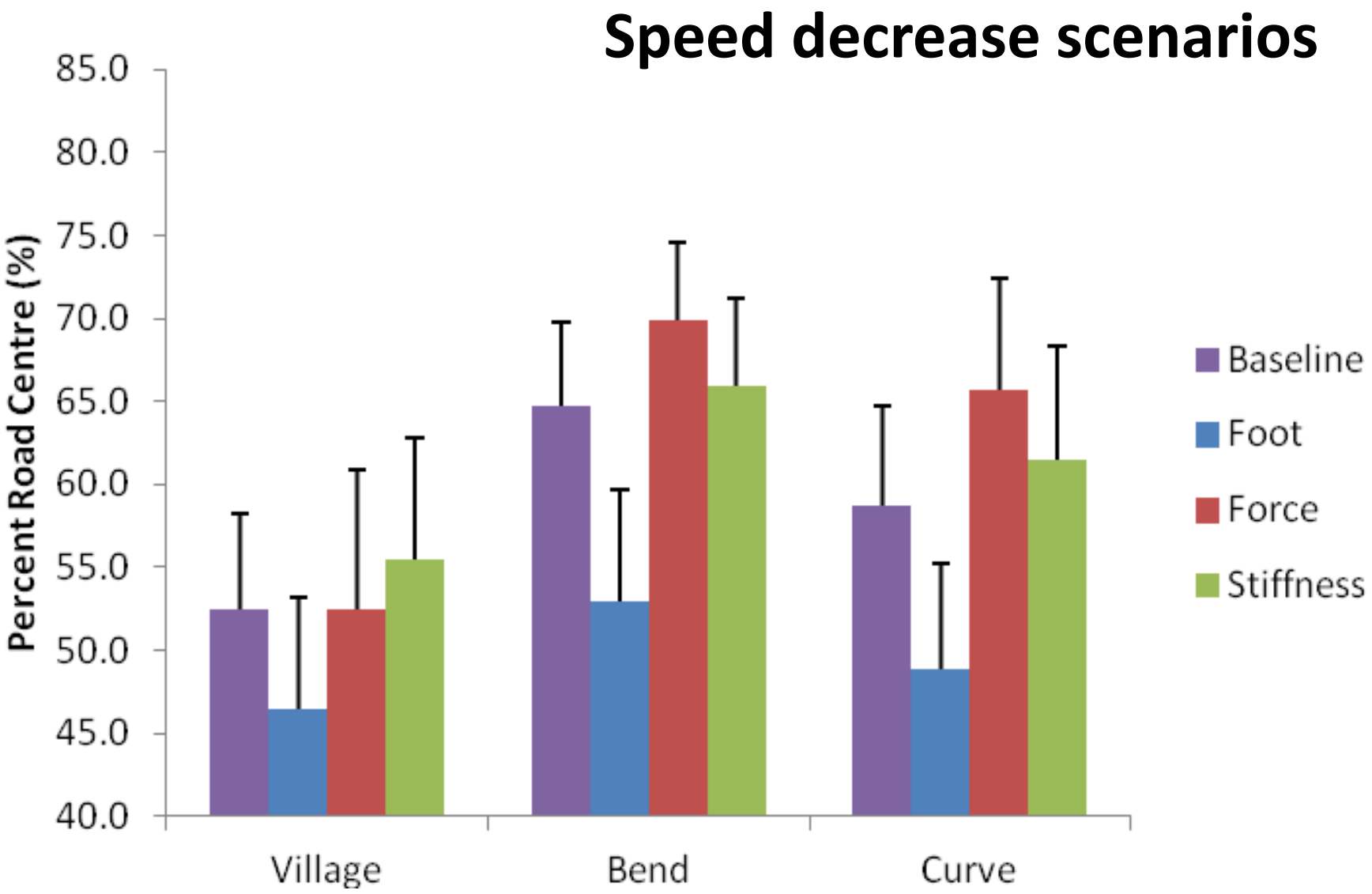


Pedal Error

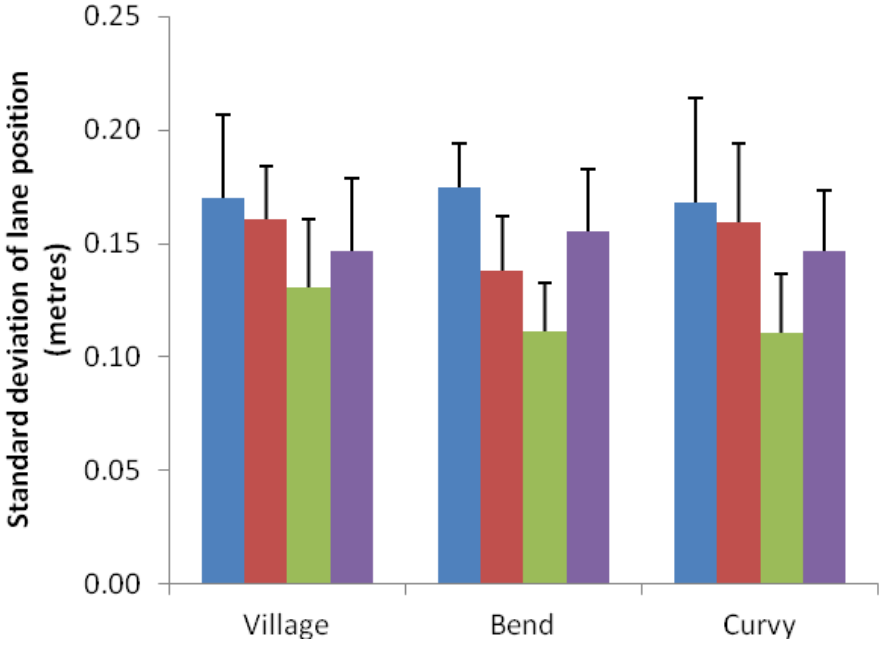
Speed increase scenarios



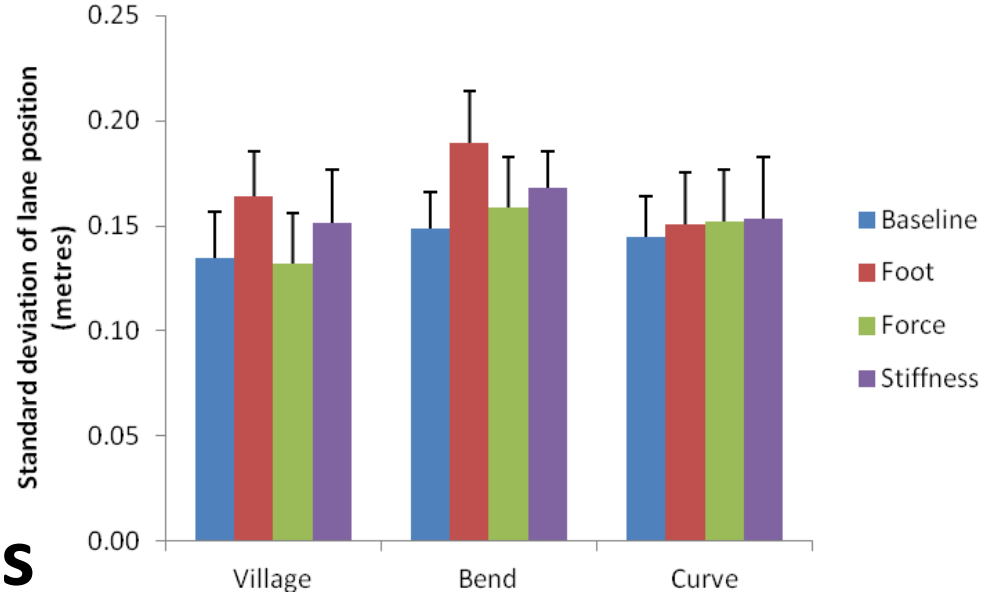
Percent Road Centre



SDLP

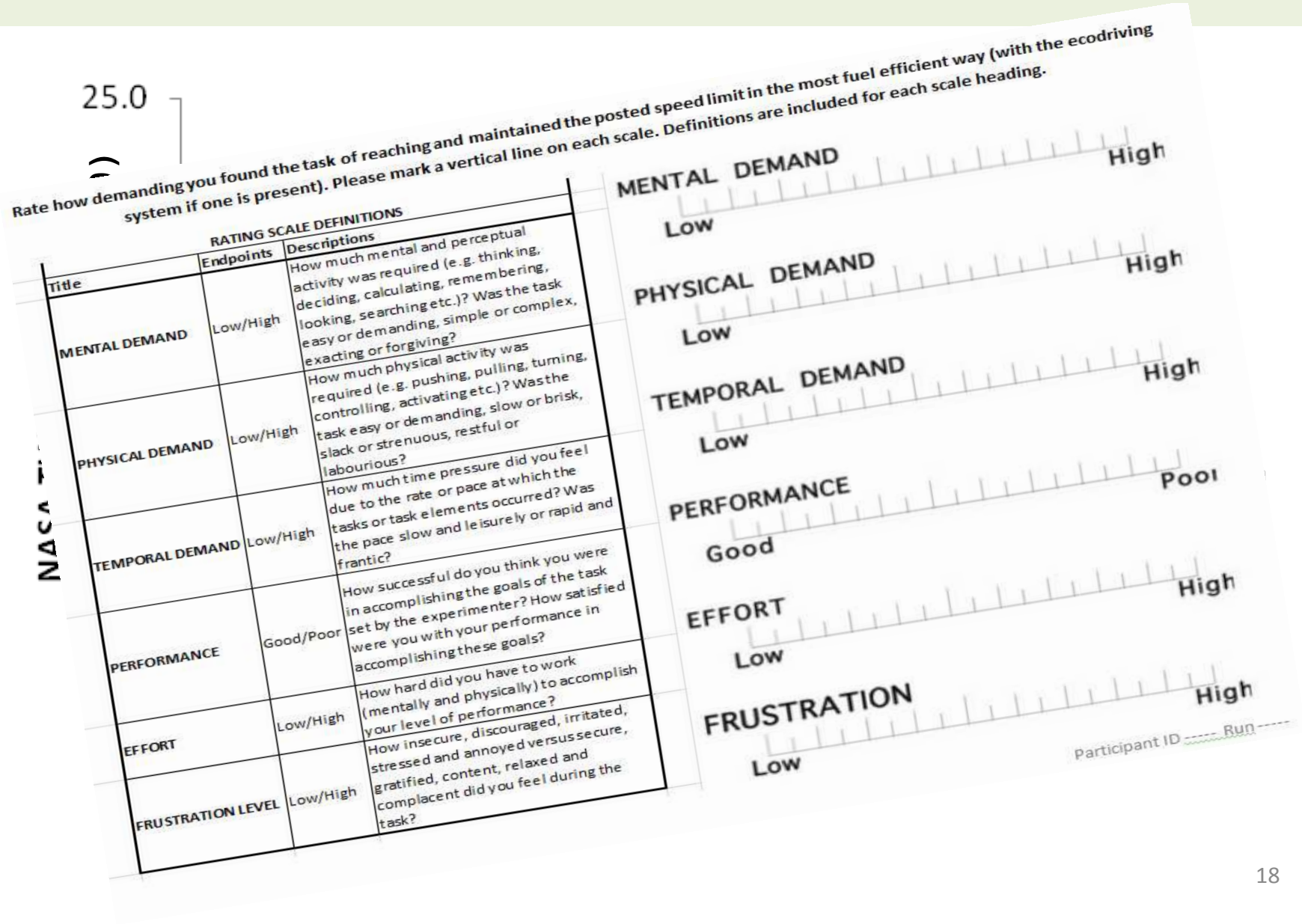


Speed decrease scenarios



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 ecodriving system if one is present). Please mark a vertical line on each scale. Definitions are included for each scale heading.

RATING SCALE DEFINITIONS

Title	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 laborious?
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?

MENTAL DEMAND — Low — High

PHYSICAL DEMAND — Low — High

TEMPORAL DEMAND — Low — High

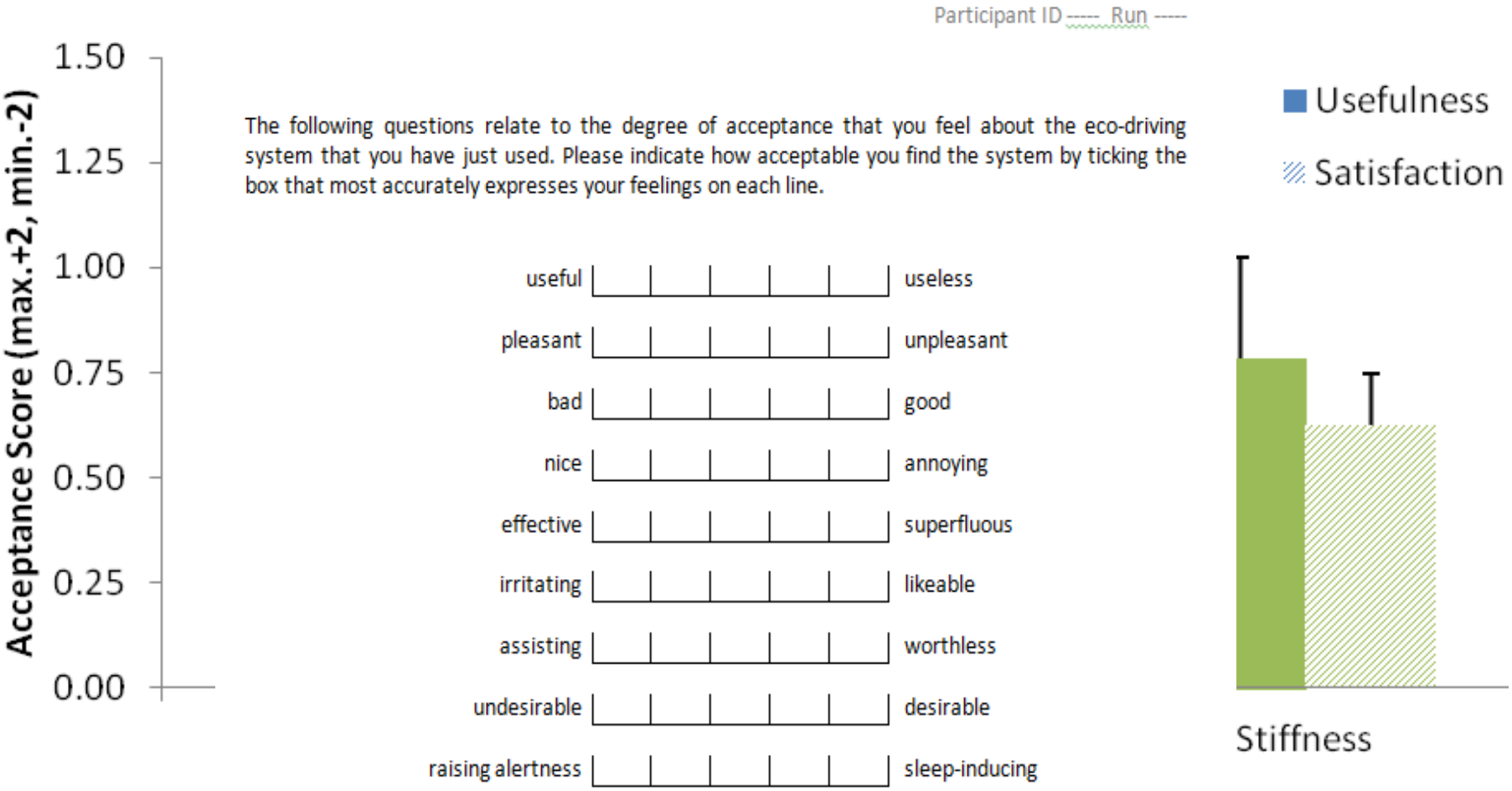
PERFORMANCE — Good — Poor

EFFORT — Low — High

FRUSTRATION — Low — High

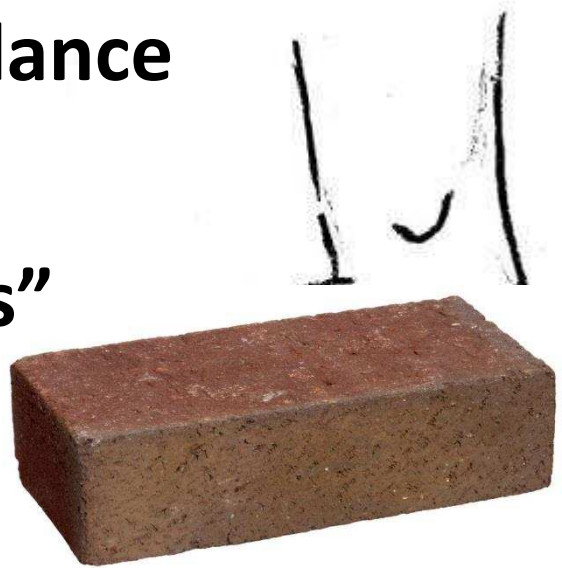
Participant ID _____ Run _____

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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