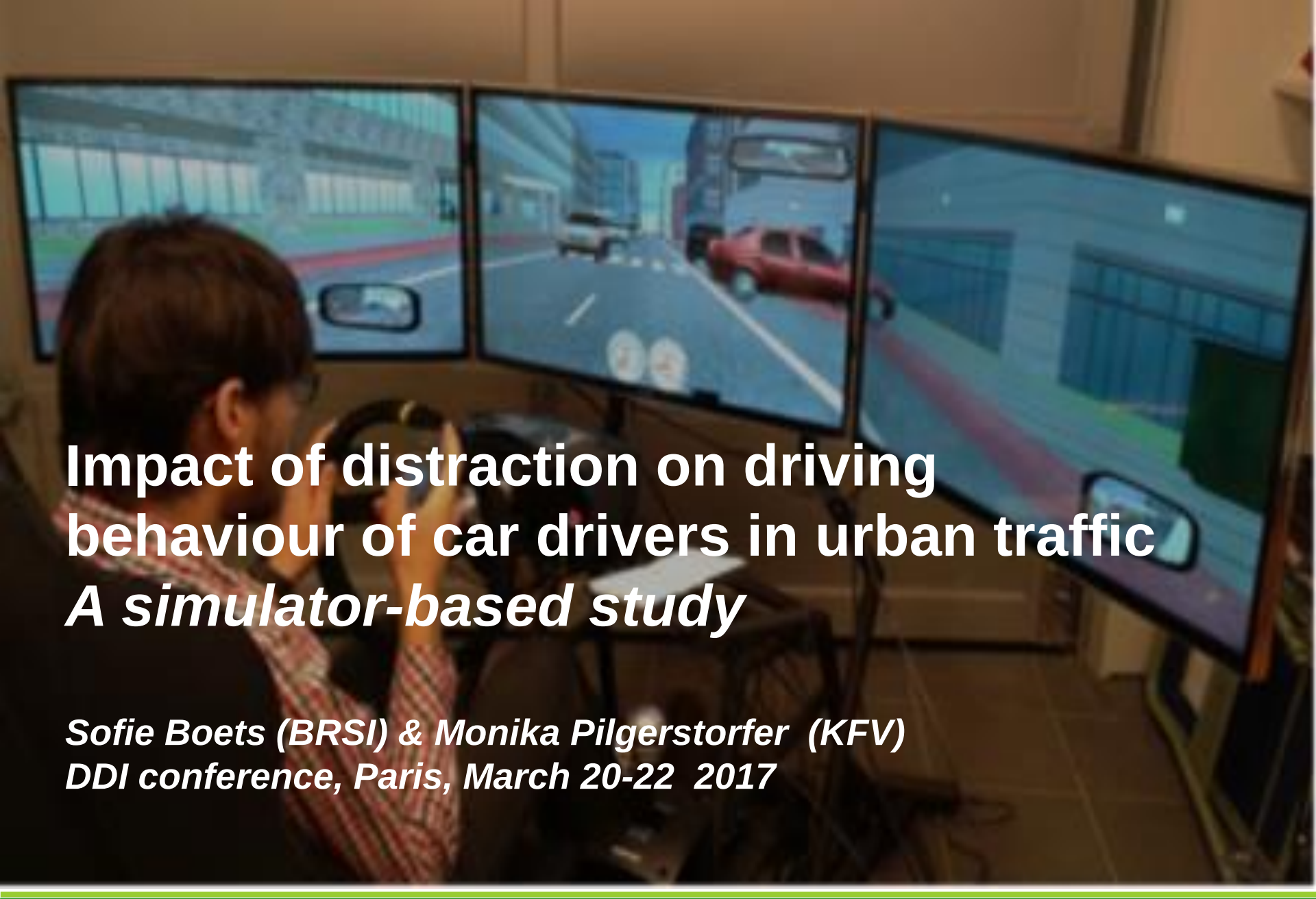

Impact of distraction on driving behaviour of car drivers in urban traffic
A simulator-based study

Sofie Boets (BRSI) & Monika Pilgerstorfer (KFV)
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Research questions

What is the impact of text reading, text writing, handheld phoning, hands-free phoning, eating and drinking

on five key driving/safety parameters in simulator	Additional effects?	Differences according to characteristics of the car driver?
• Speed • Standard deviation of lateral position • Detection time and • Reaction time to sudden critical events • Crashes	• Gaze/fixations during driving • Subjective effects on driving performance, perceived required effort	• Age: 20-34 vs. 35-49 • Gender

Methodology

Labo-experimental repeated measures design

N = 56

4 rides: 6 experimental conditions + 1 control

1) text reading (2x), text writing (2x)
2) handheld phoning (2x), hands-free phoning (2x)
3) eating, drinking (1x over 2 sections)
4) control

Counterbalanced order of rides and tasks within rides to reduce learning/fatigue effects

Simulator drive data

Eye-tracking data

Questionnaire data

Driving simulator

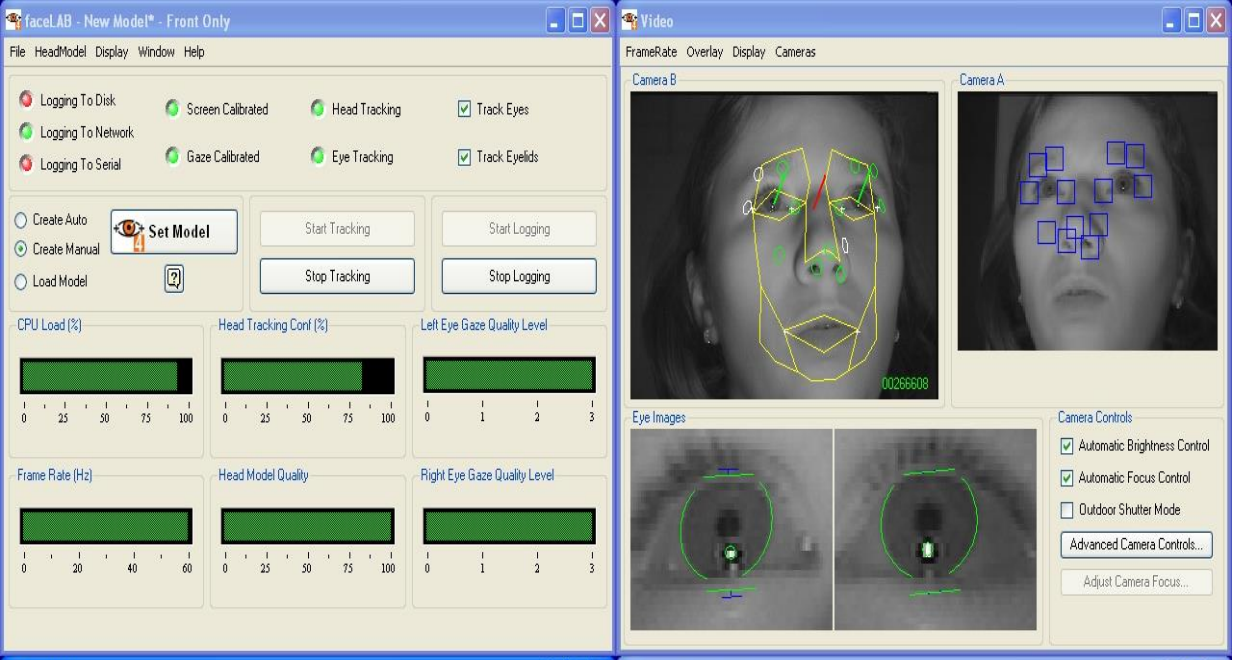
STISIM3 software

fixed base

120° field of view

simulated mirrors, speedometer

normal car controls, automatic gear



FaceLab eye-tracking

Non-invasive
Eye-tracking: 90° (central screen)
Head movements: 180°

Simulator scenarios & critical events

4 rides: 5km, 2 lane-urban road, 50km/h, light-moderate traffic, light curves left-right, daylight/good weather

Variations between rides: random other traffic, differences in road infrastructure

During distraction and control: pedestrian suddenly crosses the road, requiring a brake or full stop, depending on the driver's speed

Variations in pedestrian look and preceding road environment to reduce learning effects

Distraction tasks: operationalisation

Subjects had to start tasks when hearing a start sound during the ride:

- **Text read**: read a real-time sent standard message of 128 characters
- **Text write**: send back a text message (five examples of vacation destinations, respectively vegetables/fruits)

- **Handheld phoning**: pick-up phone and answer standard questions in a fixed order (“name five … e.g. car brands”)
- **Hands-free phoning**: earplug already in ear, open call, standard questions in a fixed order (“name five … e.g. zoo animals”)

- **Eating**: unpack and continuously eat from a sandwich
- **Drinking**: open and continuously drink from a bottle of water

Analysis drive data: (Generalized) Linear Mixed Models

5 models to estimate the effects of different independent variables

DEPENDENT VARIABLES

SPEED
SDLP
DT TO CE
RT TO CE
CRASH CE

INDEPENDENT VARIABLES

6 DISTRACTION TASKS
INTERACTIONS WITH AGE (2 catg) AND GENDER

AGE (2 catg)
GENDER
DRIVING EXPERIENCE (km last 12m)
SELF-REPORTED COMPOSITE (frequency distraction behaviour while driving)

TASK ORDER

Take into account "random effects" (heterogeneity across individuals)

Table 1. *Parameter estimates and standard errors for the different factors in the (G)LMM models for the driving variables.*

Term	Mean speed		SD of lateral position [1]		Detection time		Reaction time		Crashes	
	Est.	S.E.	Est.	S.E.	Est.	S.E.	Est.	S.E.	Est.	S.E.
Intercept	13.16***	0.36	0.20***	0.02	1.43***	0.11	1.97***	0.10	-3.89**	1.19
Text reading	-0.82***	0.19	0.05**	0.02	0.24*	0.11	0.37***	0.08	3.34**	1.15
Text writing	-1.13***	0.19	0.02 '	0.01	0.15	0.10	0.31***	0.07	1.75	1.29
Hand-held phoning	-0.68***	0.19	0.01	0.01	0.22*	0.10	0.03	0.07	1.89	1.24
Hands-free phoning	-0.30	0.19	-0.001	0.01	0.09	0.11	-0.02	0.08	2.32	1.21
Eating	-0.76***	0.19	-0.01	0.01	0.14	0.11	0.11	0.08	2.19	1.32
Drinking	-0.94***	0.19	0.02	0.01	0.12	0.10	0.11	0.07	2.19	1.30
Self-report composite	0.14	0.13			0.01	0.04	-0.01	0.04	0.16	0.21
Age category (ref: 20-34)	-0.17	0.22	0.02	0.02	0.05	0.08	0.08	0.07	1.89	1.09
Gender (ref: female)	-0.06	0.23	-0.03*	0.01	0.06	0.08	-0.03	0.07	-0.02	0.79
Km last 12months	0.08	0.10			-0.01	0.03	-0.02	0.03	-0.03	0.15
Task order (1 to 16 tasks)	0.01*	0.01			-0.01	0.00	-0.01**	0.00	-0.16***	0.03
Interactions										
read x gender	0.51*	0.21					-0.22*	0.09		
write x gender	0.63**	0.21					-0.14 '	0.08		
held x gender	0.45*	0.21			-0.24*	0.12				
drink x gender	0.75***	0.21					-0.16 '	0.08		
read x age catg.			0.05*	0.02						
write x age catg.	-0.49*	0.21					0.20*	0.08		
held x age catg.			0.05*	0.02						
eat x age catg.			0.04*	0.02						

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 ' ' 0.1

Results drive data (1)

- **Increased SDLP** during **reading**** and **writing** *(trend)* text messages
- **Detection times** to critical events are significantly **increased** during **text reading*** and **handheld phoning***
- **Significantly slower reactions** during **reading***** and **writing***** text messages
- **Increased probability for crashes** during text **reading**** compared to control condition

Significance: 0 '***' 0,001 '**' 0,01 '*' 0,05 ',' 0,1 ' ' 1

Results drive data (2)

Significantly **decreased mean speed** during:

- **reading*****
- **writing***** !
- **handheld phoning*****
- **drinking*****
- **eating*****

Significance: 0 '***' 0,001 '**' 0,01 '*' 0,05 ',' 0,1 ' ' 1

Results drive data: interaction effects

Female and middle-aged subjects more affected

Females:

- **drive slower** during **drinking***, text **writing****, text **reading*** and **handheld** phoning*
- have **higher DT** during **handheld** phoning*
- have **higher RT** during text **reading*** *(+ trend: text writing and drinking)*

Middle-aged (35-49):

- **drive slower** during text **writing***
- have a **larger SDLP** during text **reading***, **handheld** phoning* and **eating***
- **react slower** to critical events during text **writing***

Significance: 0 '***' 0,001 '**' 0,01 '*' 0,05

Results drive data: interaction effects

Female and middle-aged subjects more affected

Females:

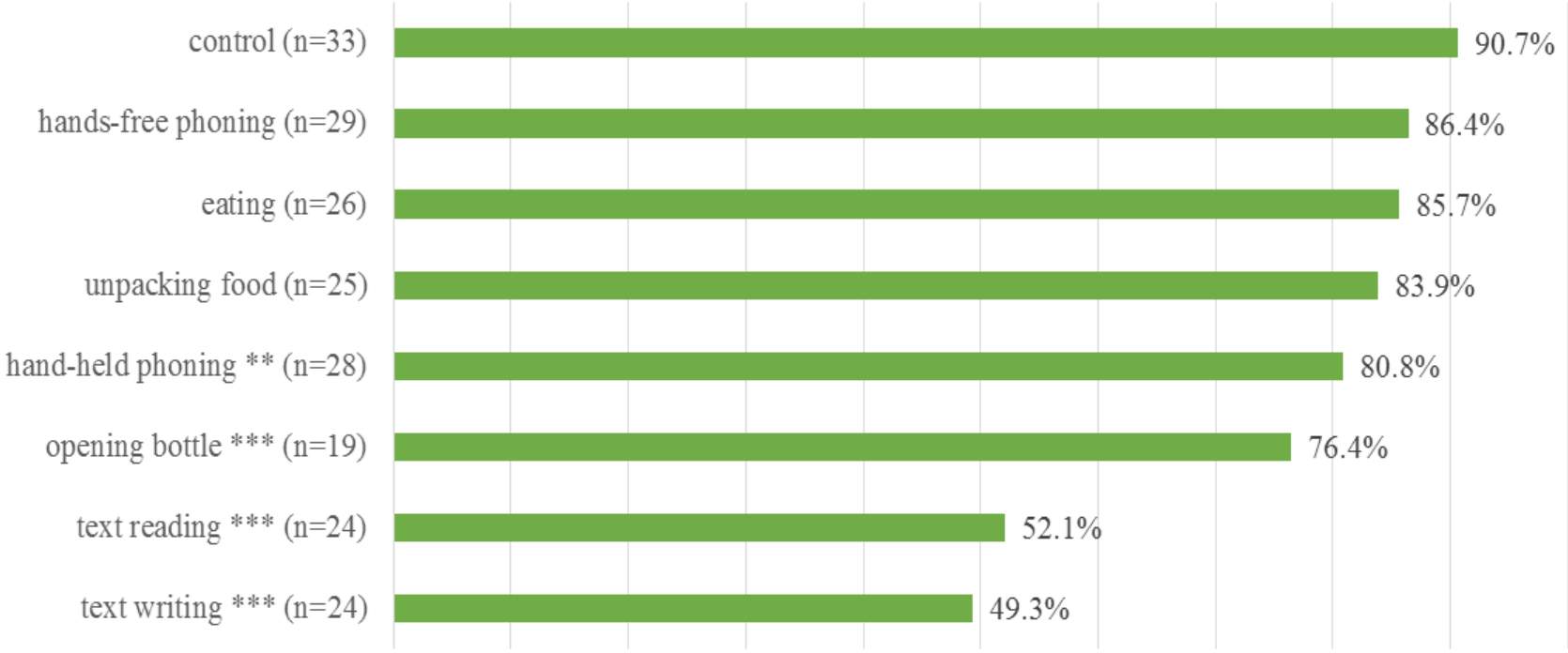
- **drive slower** text **writing****, text **reading***
- have **higher RT** during text **reading*** *(+ trend: text writing)*

Middle-aged (35-49):

- **drive slower** during text **writing***
- have a **larger SDLP** during text **reading***
- **react slower** to critical events during text **writing***

Significance: 0 '***' 0,001 '**' 0,01 '*' 0,05

Results eye-tracking data



Average gaze on driving relevant areas decreases significantly to half of the time driven during text **writing***** and **reading*****

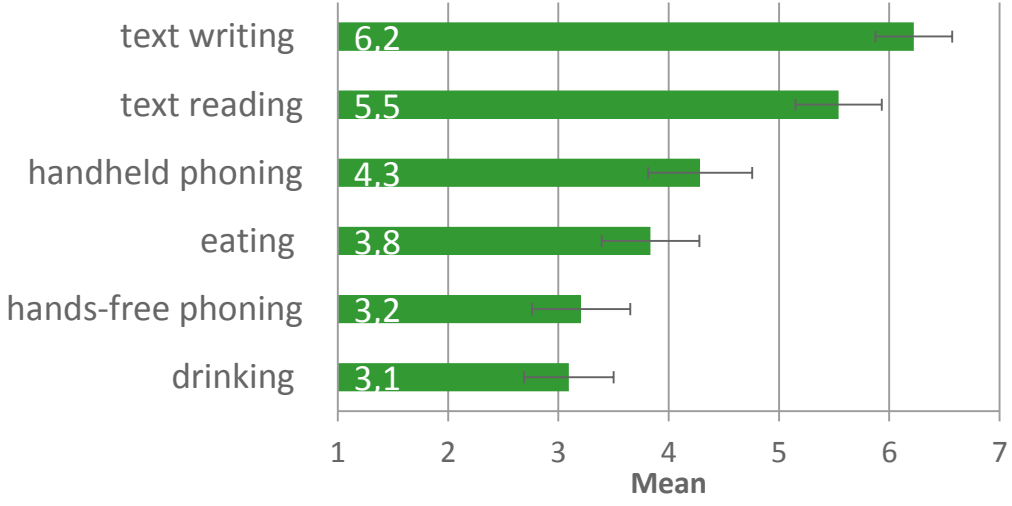
Significance: 0 '***' 0,001 '**' 0,01 '*' 0,05

Results subjective data

Fairly good correspondence of drive, gaze and subjective effects:

- Most “perceived effects” of texting (writing and reading), followed by handheld phoning, on driving performance (speed, lane keeping, hazard perception…)
- Significantly less perceived effects of other tasks (vs. texting)

- Text writing considered most effortful task, followed by text reading and handheld phoning (1: absolutely no effort - 7: extreme effort)



Results in line with survey results

- Big consensus (>80%) on **assessment** of negative effects on attention of text **writing/reading** and **handheld phoning**.
- Significantly less subjects think **hands-free phoning**, **eating** and **drinking** have such a negative effect.
- Same ‘hierarchical order’ is reflected in the **self-reported behaviour**: **text writing** is least reported.
- **Drinking** and **eating** are the 2 most reported behaviours.

Study conclusions

Texting had most negative effects on driving/gaze, followed by handheld phoning.

Lack of effects of hands-free phoning can be related to the set-up of the experiment.

General compensation mechanism of slowing down during distraction (writing)

Eating and drinking had least effects – only on gaze during opening bottle.

More effects of texting and handheld phoning on female and middle-aged subjects: decreased speed and slower detections/reactions – but for texting this may be mediated by experience with texting while driving.

Overall, good resemblance of "perceived effects" and actual effects

THANK YOU

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