



Driving distractions – What is wrong with us?

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5th International Conference on Driver Distraction and Inattention

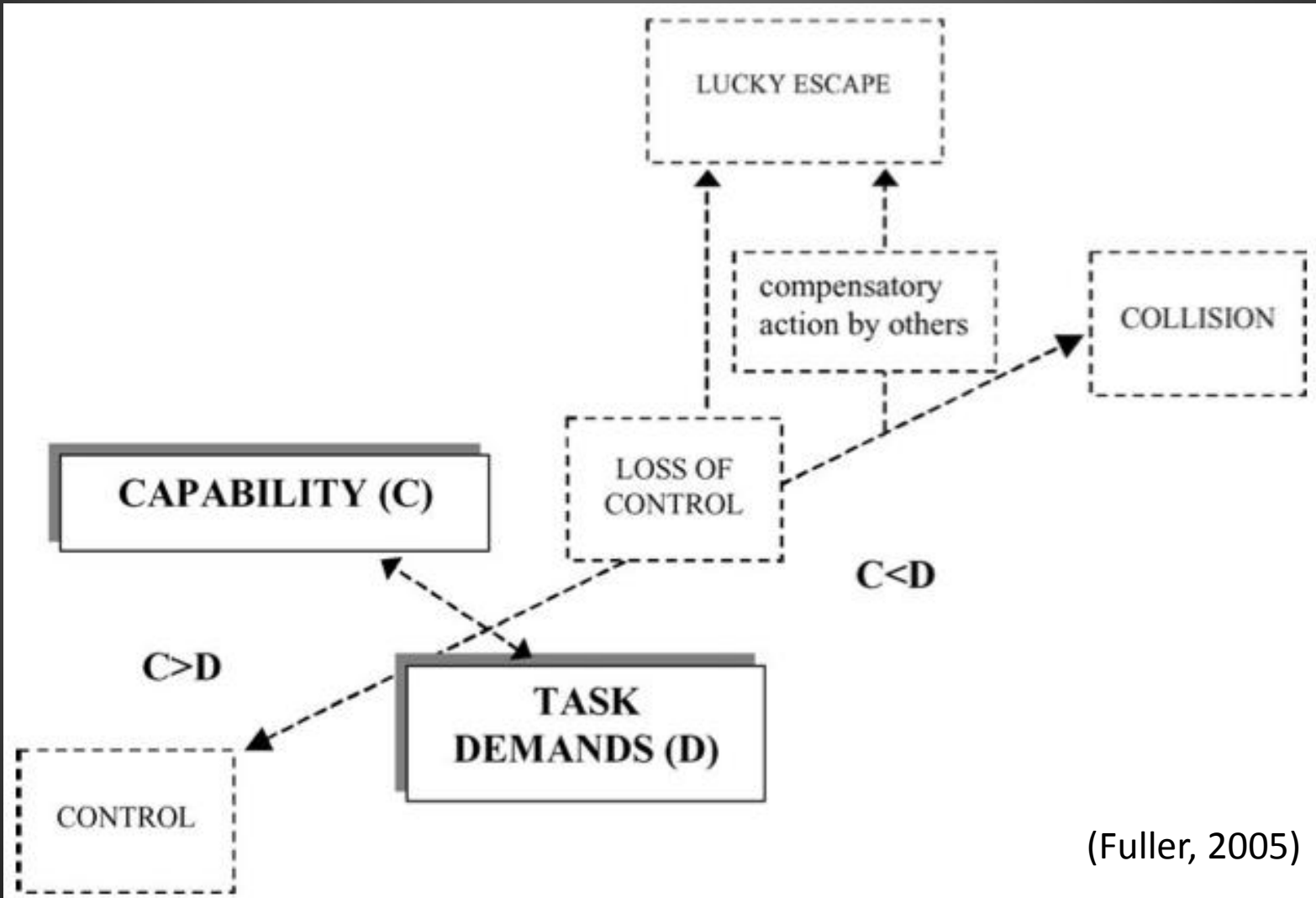
Paris, France 22.3.2017

Rolling over my parent's car back in 1998



(photo not from the actual situation but from dailybulldog.com)

Driving is a skill!



(Fuller, 2005)

Tuomo Kujala

Capacity, Workload and Mental Contents

Exploring the Foundations of Driver Distraction

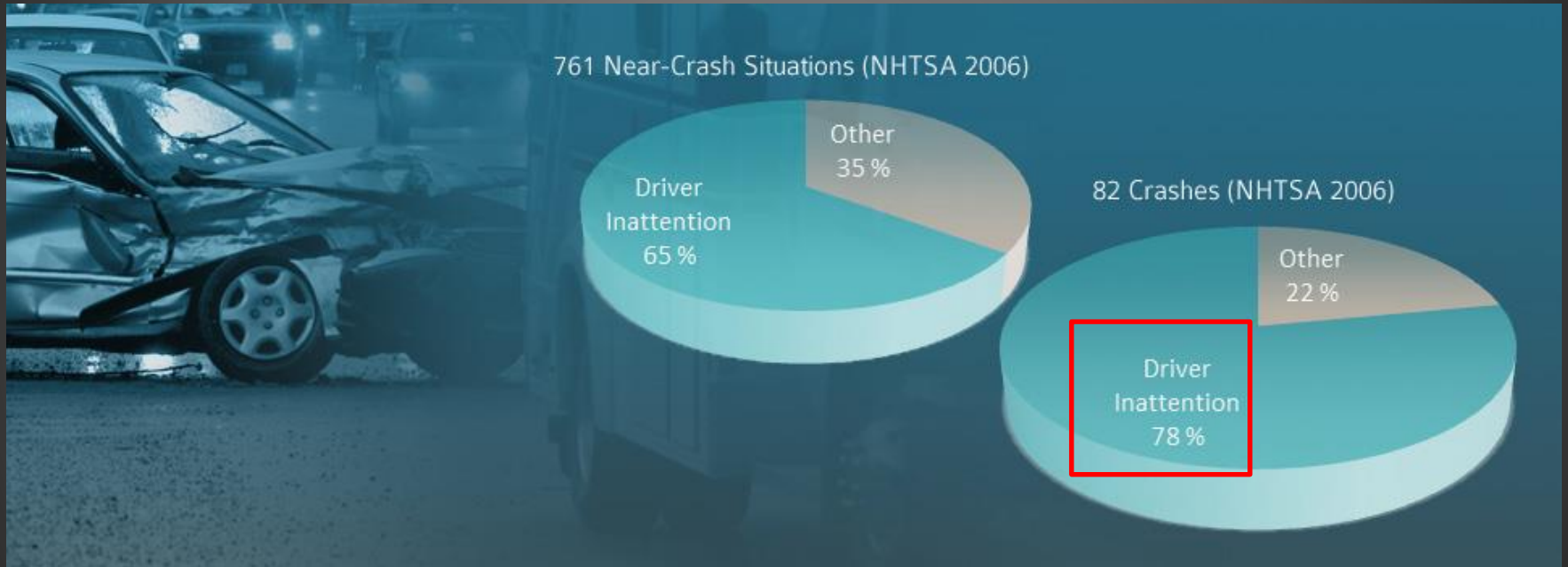


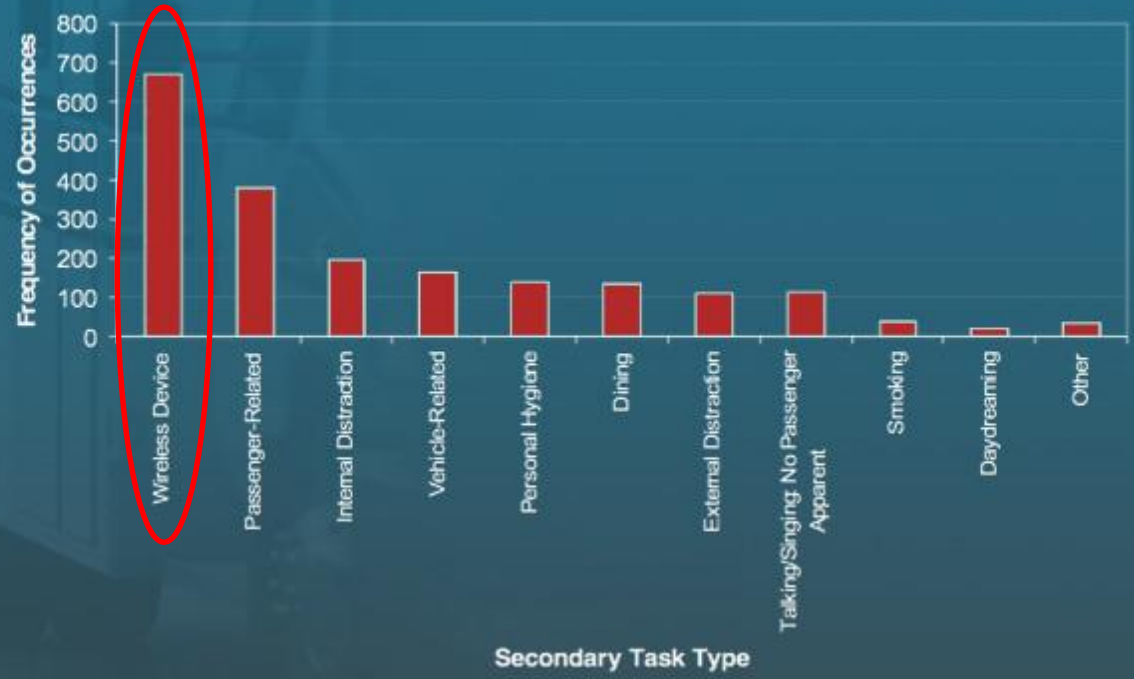
- 1930s: car radios
 - 1980-90s
 - Talking on mobile phone while driving
 - Navigation systems
 - 2000-
 - Texting was (and still is) a big topic in distraction research and campaigns.
 - At the same time, the mobile broadband enabled all kinds of interesting activities while driving...
- ➔ IS DISTRACTION OUT OF CONTROL?



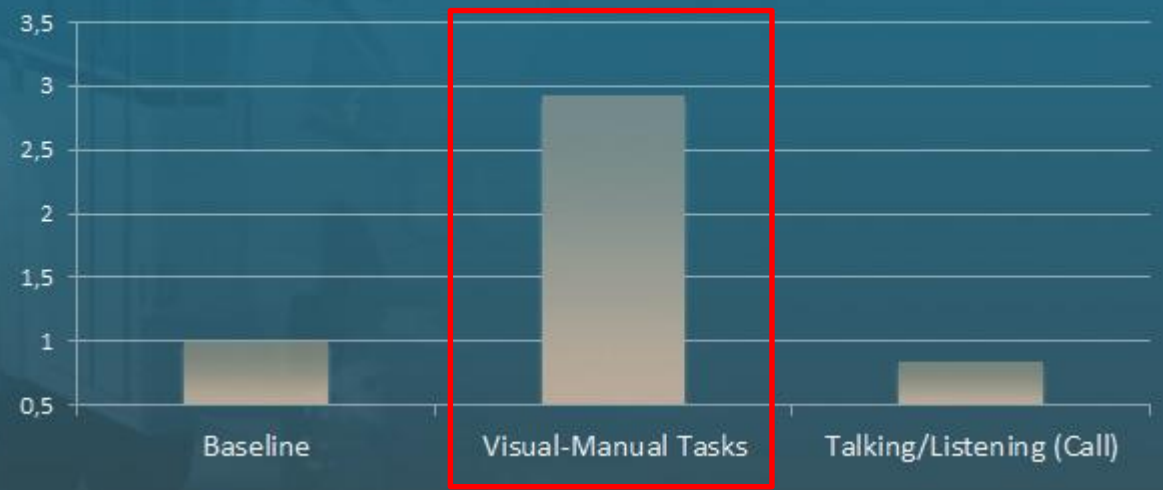
Application	N instances	Touches/instance median (15%- 85%)	Duration sec median (15%- 85%)	Speed kmh median (15%-85%)	N drivers using
Contacts	811	6 (3-21)	17 (4-57)	56 (23-93)	27
Whatsapp	614	12 (4-86)	35 (9-112)	58 (21-95)	23
Music	356	6 (3-20)	17 (3-48)	69 (30-92)	12
Maps	284	4 (1-20)	11 (1-42)	60 (18-95)	19
Facebook	210	10 (1-45)	31 (10-96)	71 (22-99)	17
PokémonGo	172	27 (7-146)	141 (29-651)	22 (10-49)	4
Search	163	14 (5-47)	34 (12-83)	55 (11-95)	11
Dialer	116	6 (3-23)	19 (4-65)	55 (17-100)	12
Browser	109	9 (3-31)	36 (5-89)	66 (28-94)	17
MMS	94	9 (4-46)	29 (7-97)	49 (20-93)	14
YouTube	64	10 (2-64)	24 (2-83)	82 (27-89)	4
Email	60	12 (5-52)	45 (14-129)	73 (24-109)	16
Banking	46	9 (3-27)	28 (6-64)	56 (19-94)	12
Email	42	12 (5-50)	45 (13-130)	73 (24-109)	9
Netflix	33	3 (1-12)	10 (1-41)	84 (59-86)	3
Calendar	31	12 (6-44)	39 (20-134)	61 (8-84)	12
Instagram	24	10 (4-75)	34 (7-128)	73 (31-100)	6
Camera	19	7 (3-45)	31 (3-69)	52 (21-96)	12
Snapchat	18	14 (4-27)	26 (7-47)	42 (29-60)	2
Gallery	17	8 (3-39)	29 (5-151)	42 (25-68)	6
Fonecta*	16	10 (5-26)	30 (9-109)	61 (18-86)	5
News	10	9 (4-17)	16 (1-52)	54 (19-118)	3
Outlook	7	8 (5-30)	37 (29-117)	88 (80-99)	2
Twitter	7	17 (8-157)	75 (25-320)	79 (33-98)	2
Tinder	5	22 (6-34)	37 (25-70)	49 (41-81)	3

Stats from the road





Safety-Critical Event Risk Associated With Cell Phone Use (NHTSA 2013)



Bans don't work

- 25 % of Finnish drivers admit texting or writing social media messages while driving
- 35% read text/SoMe messages while driving

(Finnish Road Safety Council, 2014)

Tech check

Älypuhelin ja sen integroitut sovellukset on integroitu osaksi Volkswagenia. Nyt niitä voi käyttää turvallisesti.

App-Connect: Älypuhelin osana autoa



Älypuhelimet ja niiden lukuisat sovellukset eli applikaatiot ovat yleistyneet nopeasti keskeiseksi osaksi ihmisten arkea ja samalla tärkeäksi osaksi autoa.

Älypuhelimien ja sen käyttöliittymien käyttö on meille useimmille jo niin syvällä arkirutiineissa, että tuttuja toimintoja, kuten omien soittolistojen kuuntelua musiikin suoratoistopalveluista, puhelinmuistion tai karttasovelluksen käyttöä, halutaan ja nyt myös voidaan käyttää turvallisesti autossa.

Volkswagenin App-Connect yhdistää ja integroi kaikki kolme markkinoilla toimivaa järjestelmää ja niiden autoikäyttöön sovel-

tuvat applikaatiot osaksi auton omaa informaatiojärjestelmää. Näitä ovat iPhone-puhelimiin kehitetty Apple CarPlay, Googlen Android-puhelimiin suunnittelema Android Auto ja autonvalmistajien yhteinen MirrorLink. Jokainen järjestelmä kytketään älypuhelimesta kaapeliyhteydellä auton infotainment-järjestelmän usb-porttiin.

Volkswagen App-Connect-järjestelmä toimii Volkswagenin Composition Media, Discover Media tai Discover Pro infotainment-järjestelmien yhteydessä. Apple CarPlay vaatii iOS-käyttöjärjestelmän versio 8 tai sitä uudemman. Android Auto vaatii toimiaakseen Android 5.0 -käyttöjärjestelmän tai Android Auto -sovelluksen (tulossa).

Ajaessa soittolistojen, puhelinmuistion tai karttasovelluksen käyttö on turvallista.

MirrorLink edellyttää tuen sekä puhelimen että sovelluksen.

Älypuhelimien ja infotainment-järjestelmien tiedonvaihto on järjestelmästä riippumatta sama, siksi asiakkaan vaihtaessa älypuhelimta hänen ei tarvitse vaihtaa infotainment-järjestelmää tai autoa.

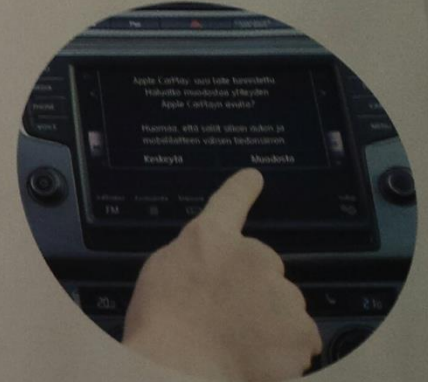
Näin App-Connect toimii:



1 Liitä älypuhelin sen omalla kaapelilla auton infotainment-järjestelmän usb-porttiin. Kaapeliyhteydellä taataan katkeamaton virransaanti ja samalla puhelimen akku latautuu.

2 Ennen yhdistämistä auton järjestelmä ja puhelin kysyvät Apple CarPlayssa yhdistämislupaa, jonka jälkeen järjestelmä on käytettävissä. Siri-puheohjaus tulee olla aktiivisena. Infotainment-näyttöön ilmestyy iPhone-sovellusvalikko. Ennen Android Auton käyttämistä pitää ladata

Suomeen vielä tulotullaan oleva sovellus Google Play-kaupasta. Sovelluksen ensinäkymänä toimii Google Now-näkymä, joka kertoo muun muassa ajankohtaiset tapahtumat. MirrorLink heijastaa kytkettäessä älypuhelimesta MirrorLink-yhteensopivat sovellukset infotainment-näytölle.



3 Valitse ja avaa applikaatio koskettamalla infotainment-näytön kuvaketta tai auton ohjauspyörässä sijaitsevaa ääniohjauspainiketta painamalla.

4 Applen CarPlay ja Android Auto toteuttavat myös äänikomentoja englantia ymmärtävän ajastajan avulla. Äänikomentotoiminto aktivoidaan painamalla ohjauspyörän äänikomentopainiketta. Äänikomentojen avulla kuljettaja voi keskittyä ajamiseen.



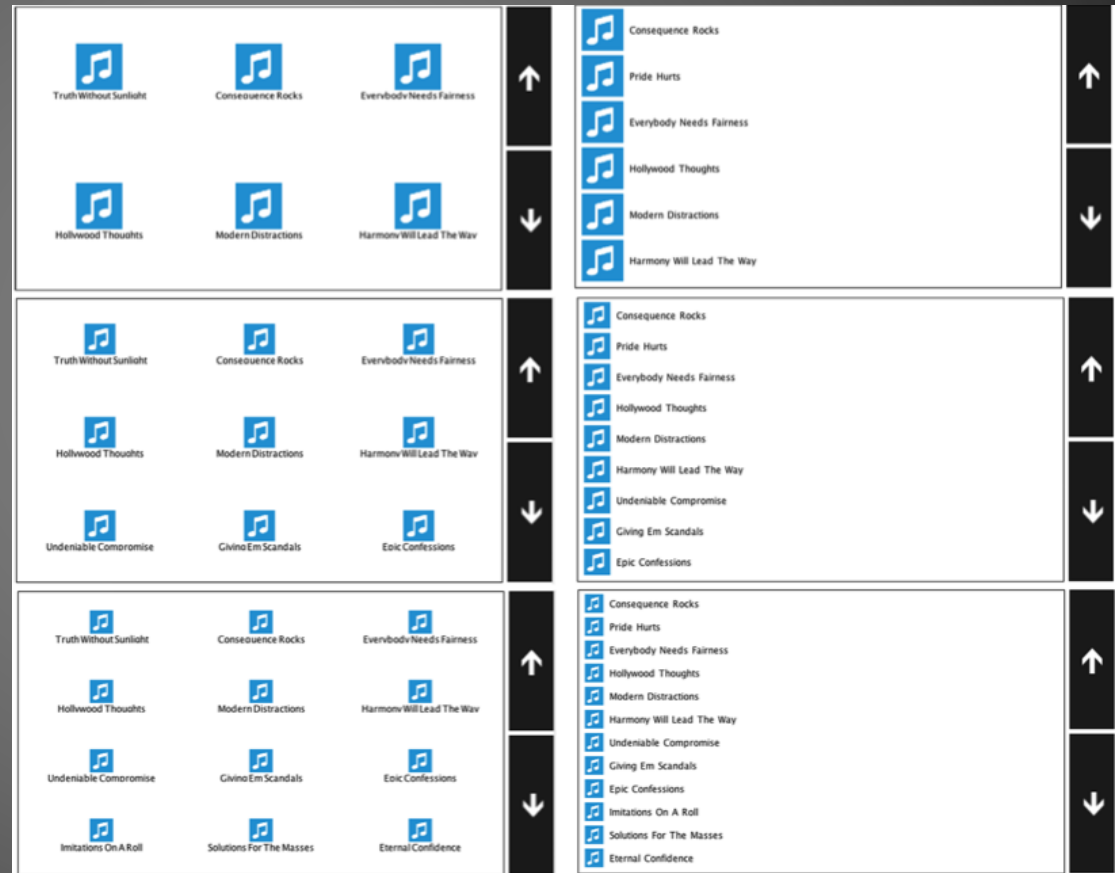
5 Apple CarPlay ja MirrorLink eivät vaadi erillistä sovellusta. Sekä CarPlay-että MirrorLink-yhteensopivat sovellukset näkyvät automaattisesti. Android Auto edellyttää erillistä sovellusta, jonka voi ladata Suomessa myöhemmin Google Play-kaupasta. Toistaiseksi MirrorLink-tuki on vain tiettyjen Android-puhelimissa.

Linkitietoa järjestelmistä yhteensopivissa:
Apple CarPlay: www.apple.com/ios/carplay
Android Auto: www.android.com/auto
MirrorLink: www.mirrorlink.com/phones



(Visual) UI design really matters for minimizing off-road glance durations!

- Not only the size of the touch screen!



(Kujala, T. & Salvucci, D.D. (2015). Modeling visual search on in-car displays: The challenge of modeling safety-critical lapses of control. *International Journal of Human-Computer Studies*, 79, 66-78.)

Could we have a **reliable** distraction
benchmarking test / rating system
for automotive UIs, comparable to
crash tests?

(cf. workshop on Tuesday)

Quick, cheap and dirty?

Low-Cost HMI Evaluation Methods to Assess Distraction and Workload

- Occlusion as in ISO 16673:2007
- Task time
- Detection reaction tasks
- Lane-change tasks
- etc.

(**See** Engström, J., Markkula, G., Victor, T., & Merat, N. (2017). Effects of cognitive load on driving performance: The cognitive control hypothesis. *Human Factors*.)

Automotive Cockpit HMI USA 2015
May 19, 2015, Detroit, Michigan, USA

ESoP or AAM (2006) etc. guidelines for in-vehicle devices

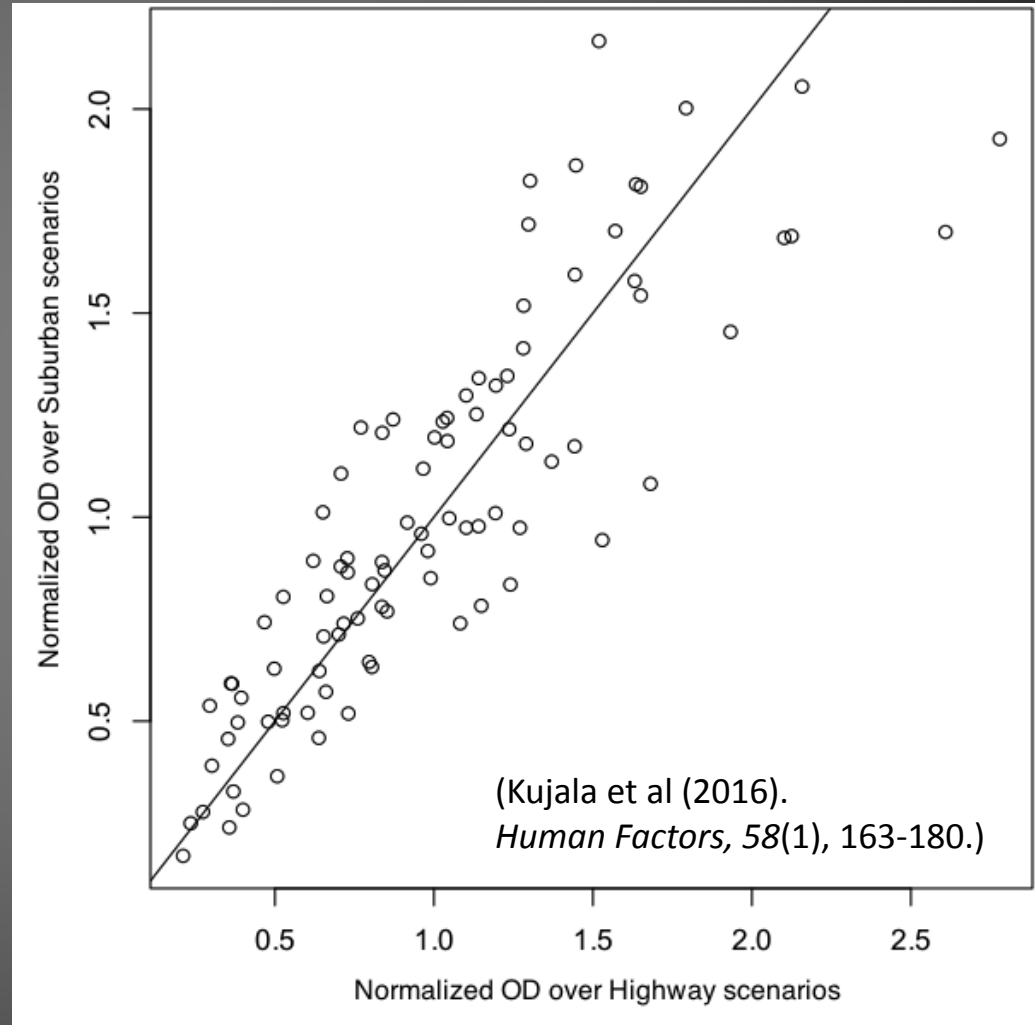
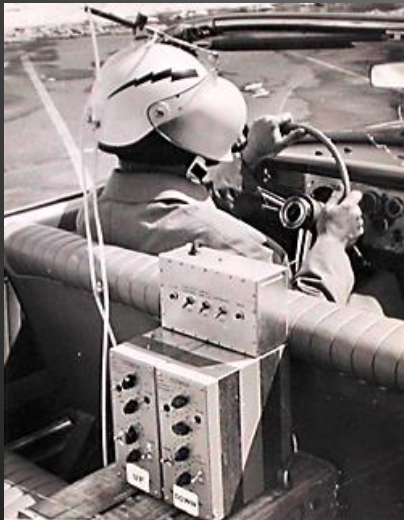
- Most of the guidelines originate from the 1980s/90s
- **Important but insufficient for the in-car infotainment systems of the 2010s-2020s.**

State-of-the-Art: NHTSA (2013)

TASK	1			2			3			4			5			6			7			8			9			10					
Synthetic test group	AC1	AC2	AC3	AC1	AC2	AC3	AC1	AC2	AC3	AC1	AC2	AC3	AC1	AC2	AC3	AC1	AC2	AC3	AC1	AC2	AC3	AC1	AC2	AC3	AC1	AC2	AC3	AC1	AC2	AC3	AC1	AC2	AC3
1	3	3	0	2	2	0	8	6	9	2	3	0	6	5	3	3	4	0	10	7	3	4	6	0	1	1	0	5	2	17			
2	4	4	0	3	4	0	8	7	13	5	5	0	9	7	2	3	3	0	12	8	3	6	7	0	1	1	0	4	2	13			
3	4	4	0	4	4	0	8	6	13	3	5	0	6	5	2	3	4	0	7	5	4	3	4	0	1	1	0	4	2	13			
4	2	2	0	3	3	0	6	5	13	2	5	0	5	4	3	2	4	0	10	7	3	3	3	0	1	1	0	5	3	14			
5	4	4	0	4	4	0	8	5	12	3	5	0	8	6	4	4	4	0	7	4	2	3	4	0	1	1	0	5	2	17			
6	2	2	0	2	3	0	9	5	12	3	3	0	6	5	2	3	3	0	7	5	4	4	6	0	1	1	0	1	1	11			
7	2	2	0	0	0	0	6	3	9	2	2	0	4	2	2	1	1	0	9	2	3	1	3	0	0	0	0	2	0	13			
8	2	2	0	1	1	0	9	4	12	2	3	0	7	3	3	0	0	0	11	5	1	3	5	0	1	1	0	4	1	17			
9	3	3	0	2	3	0	9	6	9	2	2	0	5	4	3	3	4	0	7	5	2	3	4	0	1	1	0	4	2	13			
10	2	2	0	3	3	0	4	5	11	2	2	0	8	4	2	4	6	0	10	7	5	4	7	0	0	0	0	4	2	14			
11	4	4	0	2	2	0	10	7	13	3	4	0	6	5	3	3	5	0	10	5	4	3	4	0	1	1	0	4	1	15			
12	2	2	0	1	2	0	7	6	11	4	6	0	5	4	3	2	3	0	10	8	4	4	6	0	1	1	0	2	1	12			
13	2	2	0	0	1	0	8	6	11	3	3	0	5	3	1	3	3	0	10	6	4	4	7	0	0	0	0	2	1	13			
14	3	3	0	3	3	0	7	6	11	2	5	0	6	4	2	3	5	0	11	6	3	4	5	0	1	1	0	4	1	15			
15	4	4	0	3	3	0	7	6	12	2	4	0	6	3	2	2	3	0	8	6	1	5	6	0	1	1	0	4	2	14			
16	3	3	0	4	4	0	6	7	8	2	3	0	9	5	1	4	5	0	10	6	4	4	7	0	1	1	0	4	2	12			
17	4	4	0	3	4	0	6	6	8	4	3	0	9	6	3	4	4	0	10	5	1	3	5	0	0	0	0	5	3	16			
18	2	2	0	1	2	0	8	3	11	3	4	0	5	3	4	1	3	0	8	7	2	4	5	0	1	1	0	2	1	17			
19	2	2	0	3	3	0	10	6	11	2	5	0	9	6	1	4	6	0	9	8	3	5	7	0	1	1	0	3	2	15			
20	1	1	0	2	2	0	9	6	12	3	6	0	8	5	2	1	1	0	8	6	3	4	5	0	1	1	0	5	2	16			
21	2	2	0	3	4	0	9	7	8	2	7	0	5	5	3	5	6	0	13	9	3	4	6	0	1	1	0	3	3	16			

(Aust et al., 2015)

Individual preferences for the off-road glance lengths ignored!



(YouTube: Pioneer Days on Rt 128)

Definition...?

- Driver inattention (and distraction) refers to “**insufficient**, or no attention, to **activities critical for safe driving**”

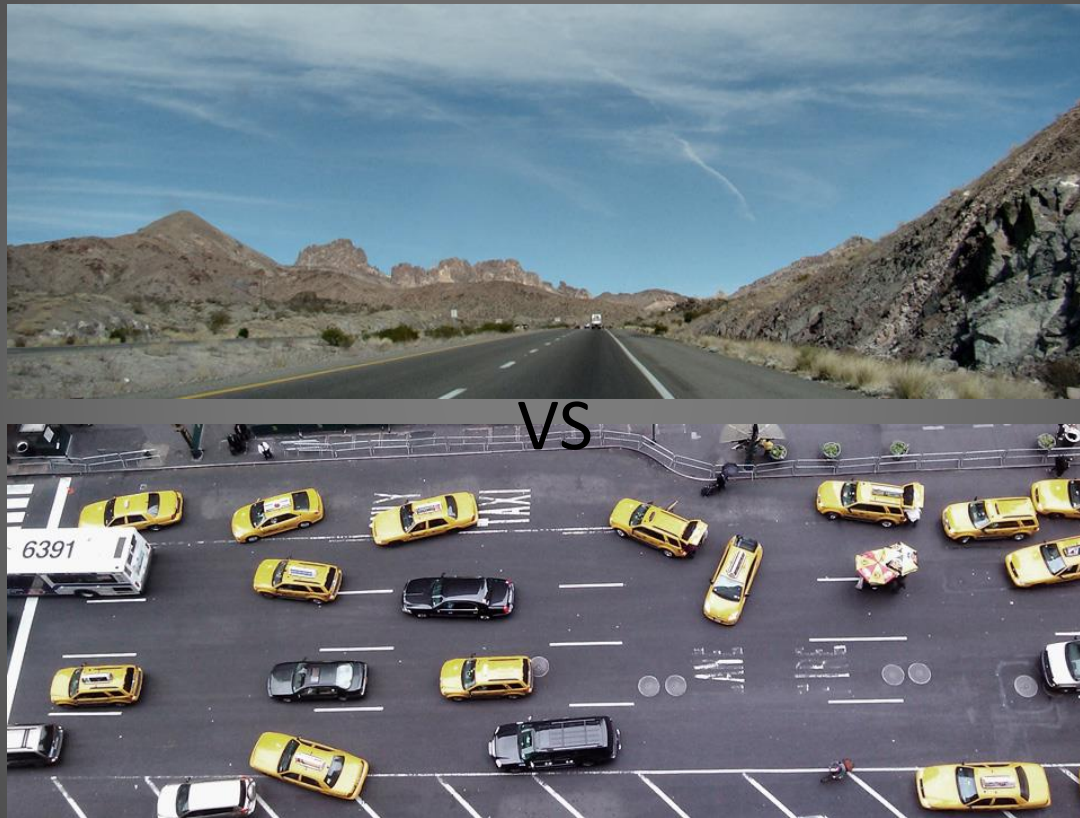
(Regan, Hallet, & Gordon, 2011, p. 1775)

- Hindsight bias (Kircher & Ahlstrom, 2017)?

Visual Distraction

- Significant association with safety-critical incident risk in naturalistic data
- According to statistics, it is **always** a bad idea to look off road for more than 2 (or 1.7 or n) seconds while driving. (e.g., Liang, Lee, & Yekhshatyan, 2012)
- But: eyes off road for too long **or at the wrong moment? (timing!)**

Context-dependency of distraction (and risk) – Timing!



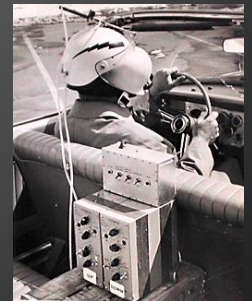
- “The probability of a rear-end crash is zero, if the road is empty.” (Trent Victor, Volvo, DDI’2015)

The Distraction Myth

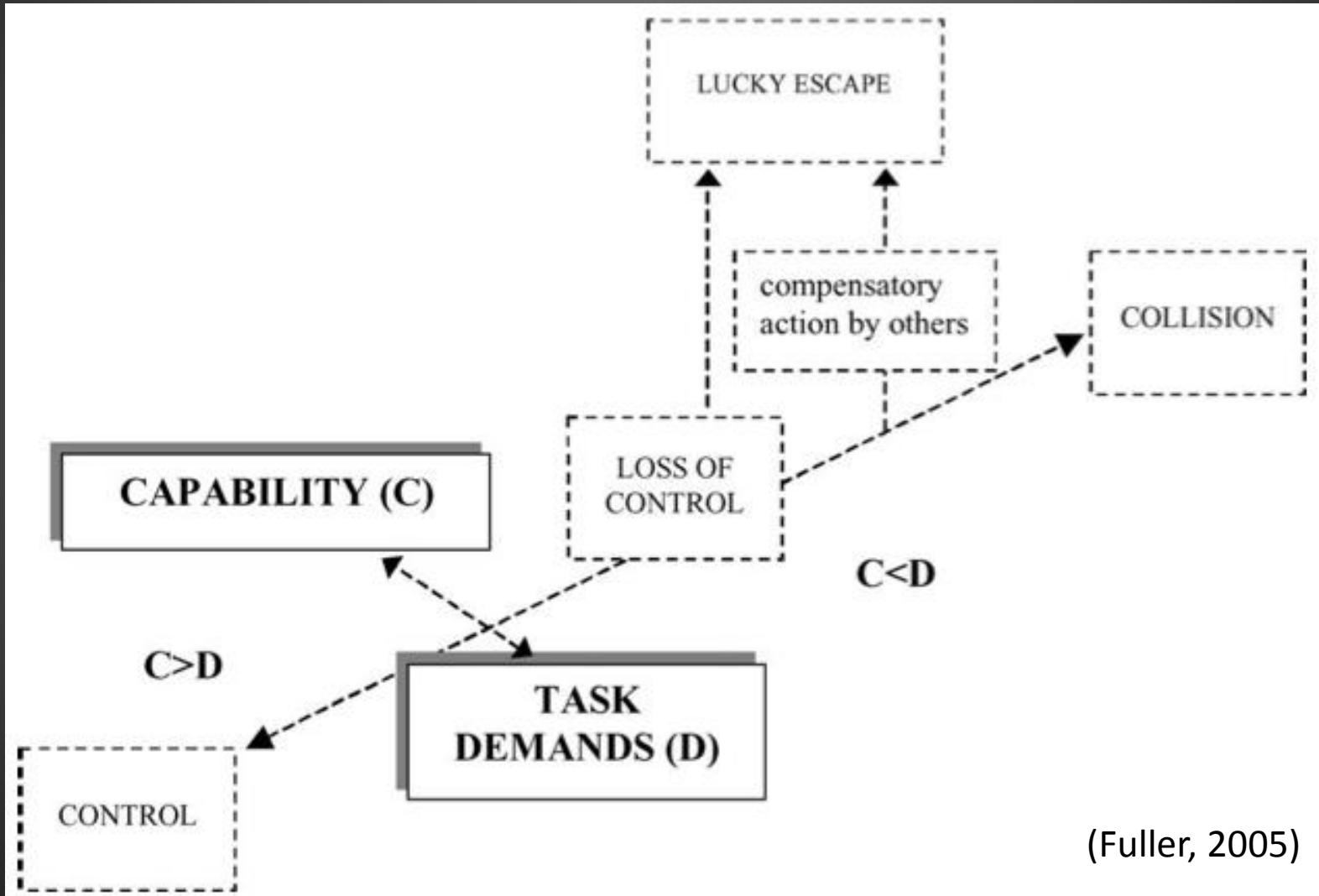
- “The driver should keep both hands on the steering wheel (on 10 and 2), eyes on the road, and mind on the driving task **at all times.**”
- It's impossible for a human being.
(maybe for a race car driver)

Turn

- **How much attention do YOU need to drive safely in a particular situation?**
- Minimum Required Attention (MiRA, Kircher & Ahlstrom, 2017)
- E.g., the original visual occlusion method (Senders et al. 1967)
- **Uncertainty**

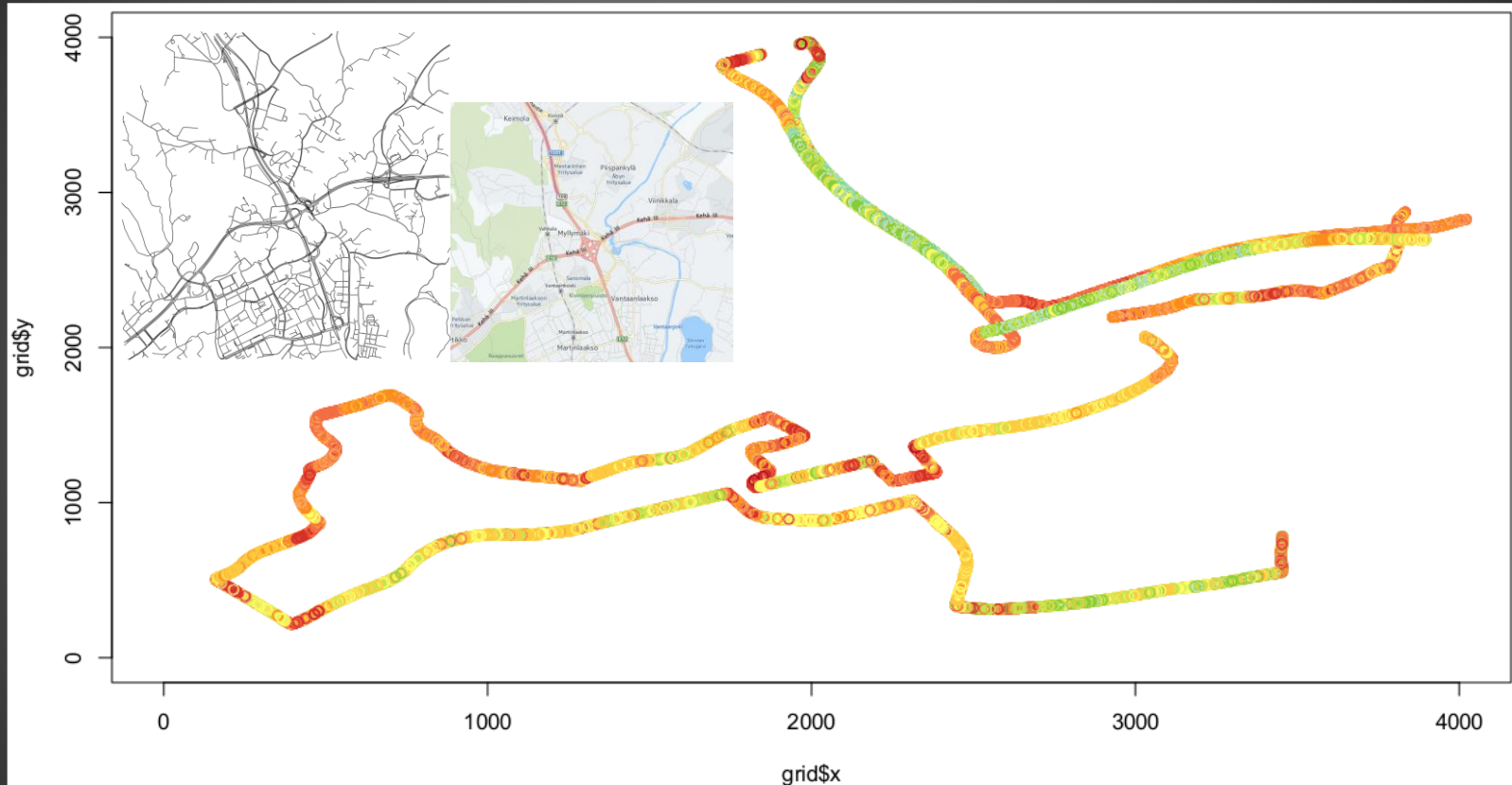


Multitasking while driving is a skill!



(Fuller, 2005)

Occlusion distance (OD) as the baseline for visual distraction



Kujala, T., Grahn, H., Mäkelä, J., & Lasch, A. (2016). On the visual distraction effects of audio-visual route guidance. In *Proceedings of AutomotiveUI'16*. ACM.

Kujala, T., Mäkelä, J., Kotilainen, I. & Tokkonen, T. (2016). The attentional demand of automobile driving revisited: Occlusion distance as a function of task-relevant event density in realistic driving scenarios. *Human Factors*, 58, 163-180.

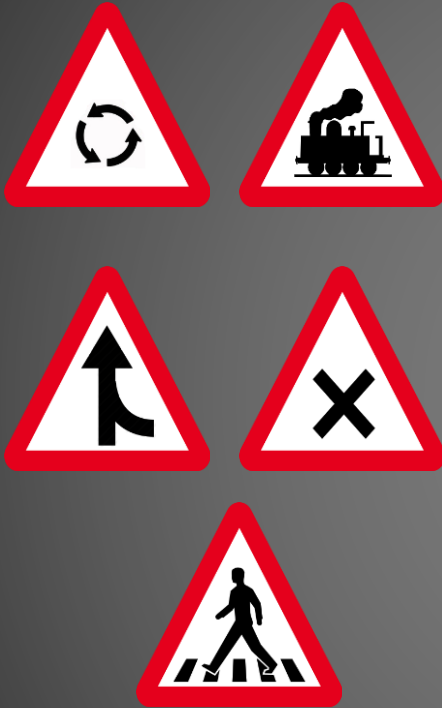
Kujala, T., & Mäkelä, J. (2015). Testing environment and verification procedure for in-car tasks with dynamic self-paced driving scenarios. In *Proceedings of the 4th International Conference on Driver Distraction and Inattention*.

Results – OD-based Distraction Tests

In-car task	UI / Device	RED in-car glances (%, median)	PASS / FAIL (one-sample test)
Email (read)	Email / Samsung Galaxy A3	20.00	FAIL
Text entry	Touch screen keyboard, Carrio / 7" tablet	13.22	FAIL
6% Spotify search (track + artist's top tracks)	Voice recognition + manual search, Carrio / 7" tablet	6.00	PASS
Text entry	Voice recognition, Carrio /7" tablet	3.51	PASS
Call / Music search / AV route guidance	Nuviz HUD + 5-button steering column controller	3.41	PASS
Audio-visual route guidance*	HERE Auto / 7" HDMI capacitive touchscreen monitor	0.00 - 2.50	PASS

(Mostly yet unpublished, *Kujala, T. et al. (2016). On the visual distraction effects of audio-visual route guidance. In *Proceedings of AUI'16*)

Location-based warnings



Displayed, if the driver uses smart phone on the move (display on and last touch < 30 s)

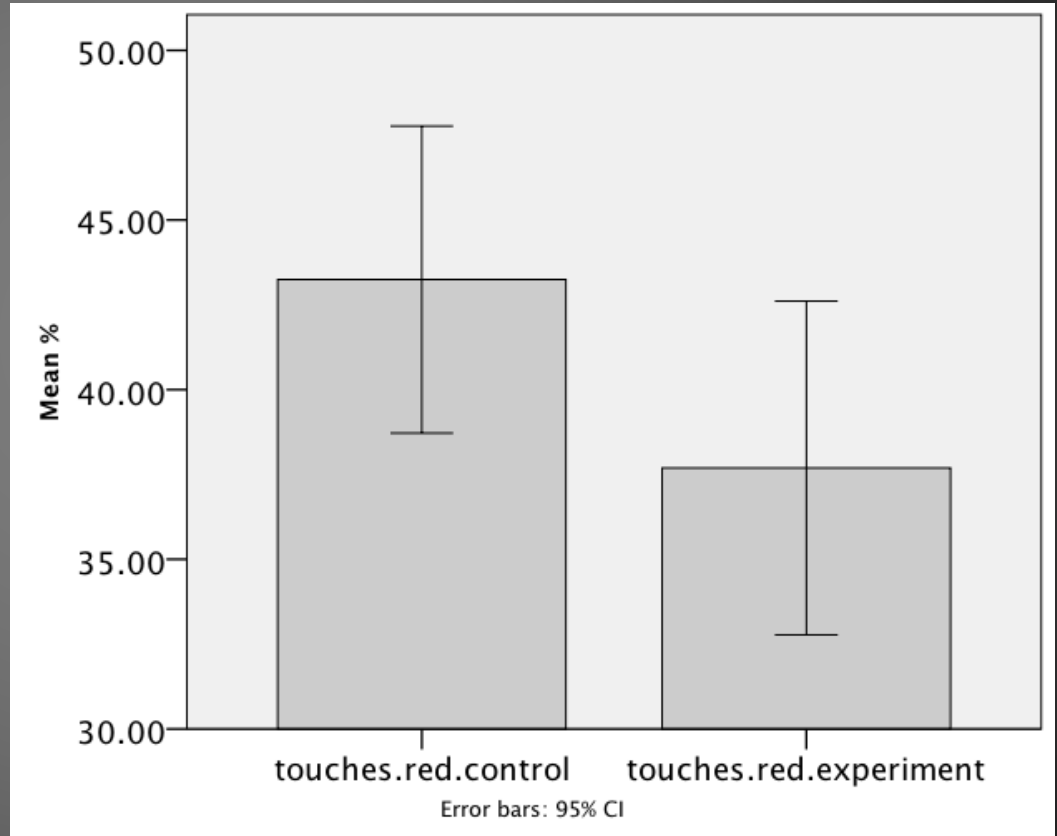
vi Reminder application for context-sensitive distraction prevention



- Auto-start
- Touch while reminder on → warning (blinking + sound)

Effect of reminders/warnings ($N=27$)

- On average 13 % reduction in smart phone use in high-demand situations compared to control conditions (no warnings, $p < .05$)
 - at best 79.0 percentage units decrease



Experiences ($N=30$)

Metric	Items	Alpha	Mean (SD) 1-5 (5 best)	One-sample test (>3), Sig.
Reminders	5	.72	4.12 (.68)	$p < .0001$
Sound warnings	4	.84	3.91 (1.01)	$p < .0001$
Timing	4	.69	4.03 (.68)	$p < .0001$
Usefulness	5	.88	3.99 (.85)	$p < .0001$
Acceptability	3	.87	3.87 (1.03)	$p < .0001$

(Yet unpublished)

Near future looks troublesome

Level	Name	(SAE J3016) Narrative definition	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of <i>dynamic driving task</i>	System capability (<i>driving modes</i>)
<i>Human driver</i> monitors the driving environment			Human driver	Human driver	Human driver	n/a
0	No Automation	the full-time performance by the <i>human driver</i> of all aspects of the <i>dynamic driving task</i> , even when enhanced by warning or intervention systems				
1	Driver Assistance	the <i>driving mode</i> -specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the <i>human driver</i> perform all remaining aspects of the <i>dynamic driving task</i>	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the <i>driving mode</i> -specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the <i>human driver</i> perform all remaining aspects of the <i>dynamic driving task</i>	System	Human driver	Human driver	Some driving modes
<i>Automated driving system</i> ("system") monitors the driving environment			System	System	Human driver	Some driving modes
3	Conditional Automation	the <i>driving mode</i> -specific performance by an <i>automated driving system</i> of all aspects of the <i>dynamic driving task</i> with the expectation that the <i>human driver</i> will respond appropriately to a <i>request to intervene</i>				
4	High Automation	the <i>driving mode</i> -specific performance by an <i>automated driving system</i> of all aspects of the <i>dynamic driving task</i> , even if a <i>human driver</i> does not respond appropriately to a <i>request to intervene</i>				
5	Full Automation	the full-time performance by an <i>automated driving system</i> of all aspects of the <i>dynamic driving task</i> under all roadway and environmental conditions that can be managed by a <i>human driver</i>	System	System	System	All driving modes


Blame Game

“Tesla driver dies in first fatal crash while using autopilot mode” (www.theguardian.com)

- 1) Experimenting with the customers, or
- 2) Designing the system foolproof before the launch?

Conclusions

- Safety should matter.
- Let's do more (and better) work to make it matter!

Thank you for your undivided
attention. 

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