



Driving with redundant information: What are the advantages?

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Introduction



- Driving process is highly visual

Peacock & Karwowski (1993)

- Cognitively taxed drivers are slower to react to unexpected events.

Wikman, Nieminen, & Summala (1998)

- Driver's who engage in distracting activities are often unaware of the risks taken.

Wittmann, M., et al. (2006)



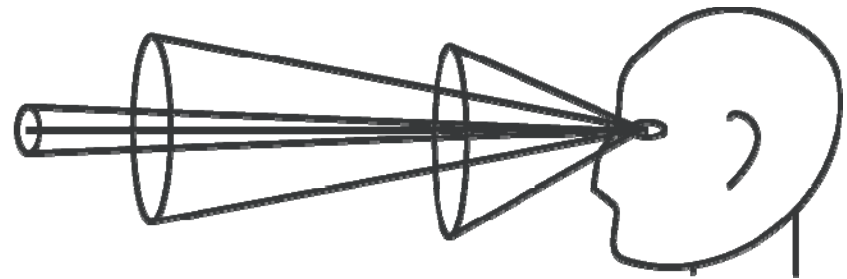
Background

Displays within 15°

- Help reduce distraction
- Better for secondary tasks
- Clutter can cause cognitive overload

Lamble, Laakso, Summala (1999)

Wittmann, et al. (2006)



Siemens VDO, 2006

Research questions

1. How do drivers respond to redundant information in HUD and HDD for conducting tasks?
2. What are the benefits and disadvantages of the redundant layout?
3. What is the cognitive workload, perceptions of usability and acceptance concerning display placements.



Method - Respondents



- Simple task & Complex task
- 20 respondents – 10 females and 10 males
- Age – 39 yrs & 41 yrs
- License – 19 yrs & 21 yrs
- Distance/week – 138 km & 151 km



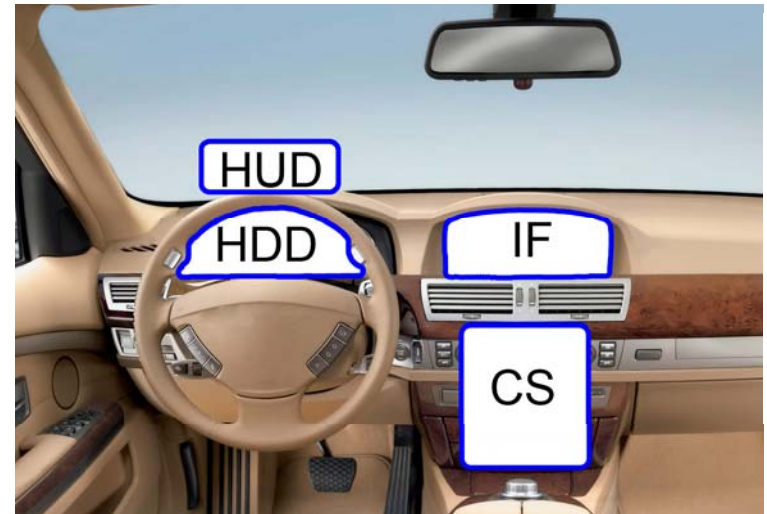
Method – Driving Environment



HUD – 8" LCD 10° to 12 ° down

HDD – 12" LCD 18° to 22° down

CS – 12" touch screen, 30° to the center and 30° down



- Adjust temperature to 22° C
- Call 0703679324



Method – Driving Environment



HU

HD

CS

cer



Method – Road environment

- Practice 10min
- Baseline 15km
- Experiment 15 km

10 warnings – Simple task

Press button when warning shows up

10 instructions – Complex task

"Adjust temperature to 22° C" "Activate CD" "Change CD to track 5"
 "change to lowest volume" "Activate MP3" "Change to album 'French Pop'"
 "Raise volume 2 levels" "Call 0703679324" "Increase Fan 2 levels" "Call
 0706862584"

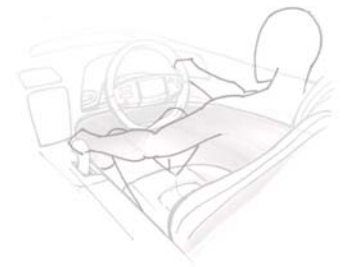
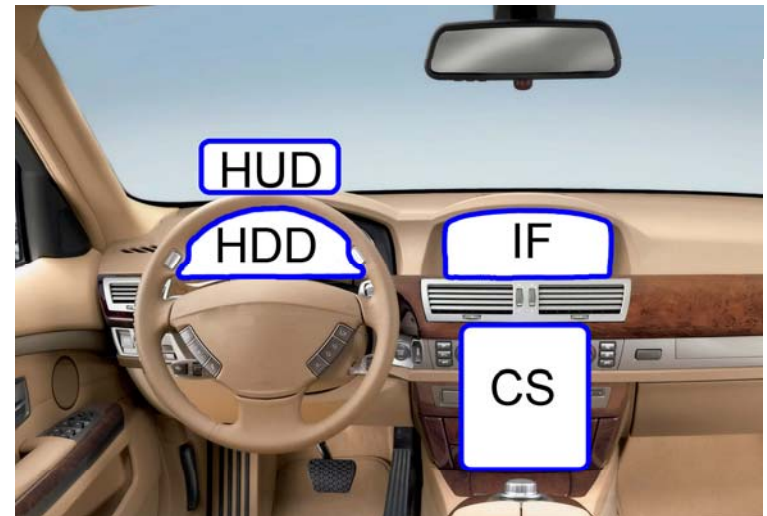


Method - Procedure

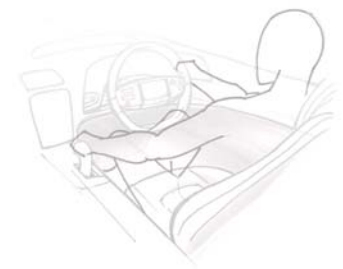
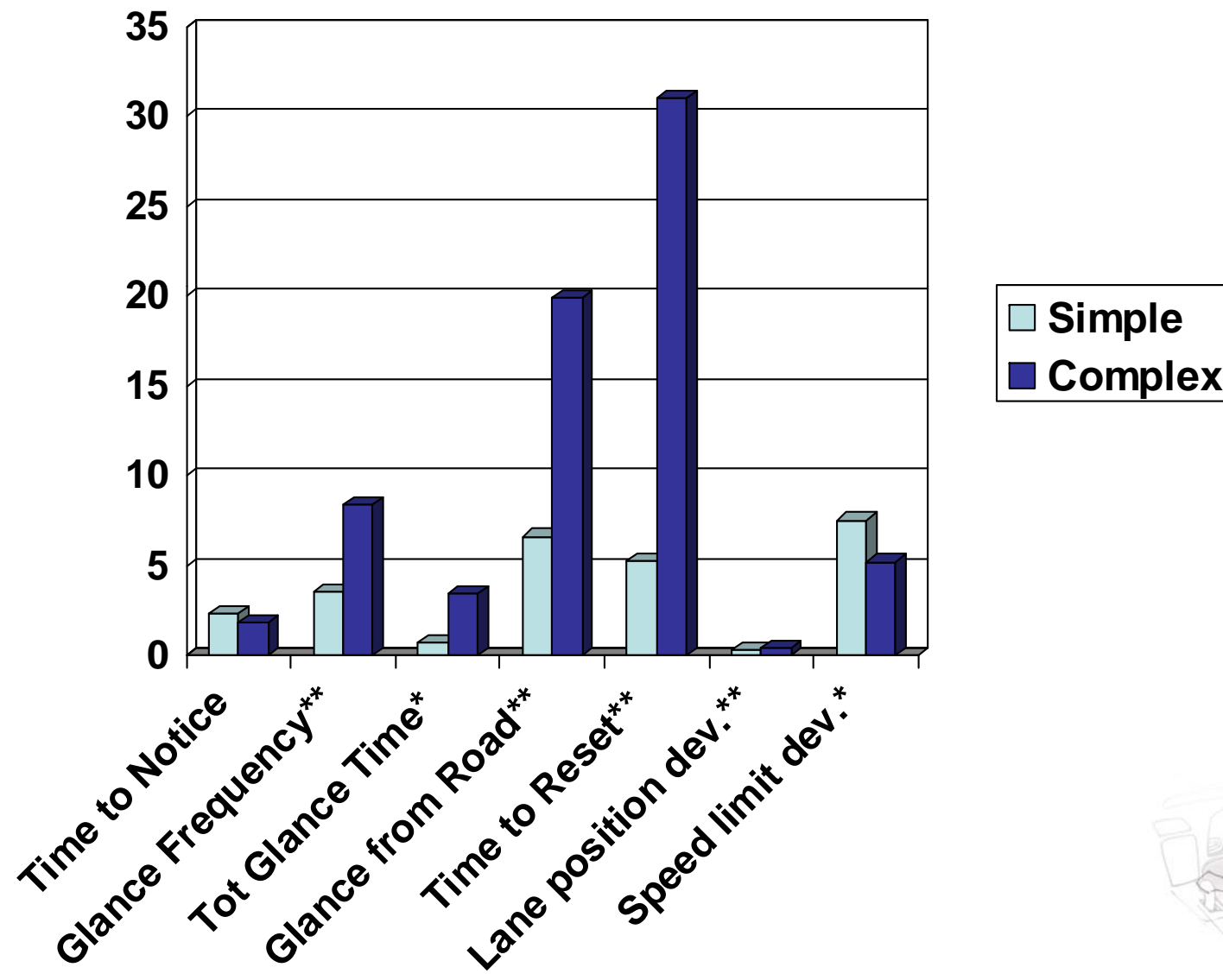


Analysis

- Eye-tracking
- Driving data
- DALI
(Driving Activity Load Index)
- Interview
- Simultaneous HUD & HDD messages



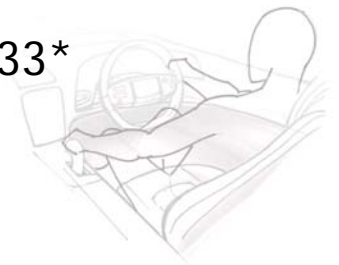
Results – Driving task



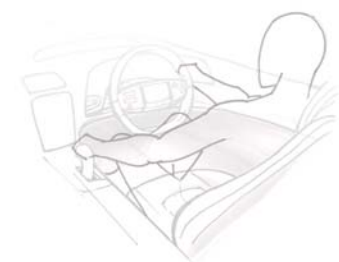
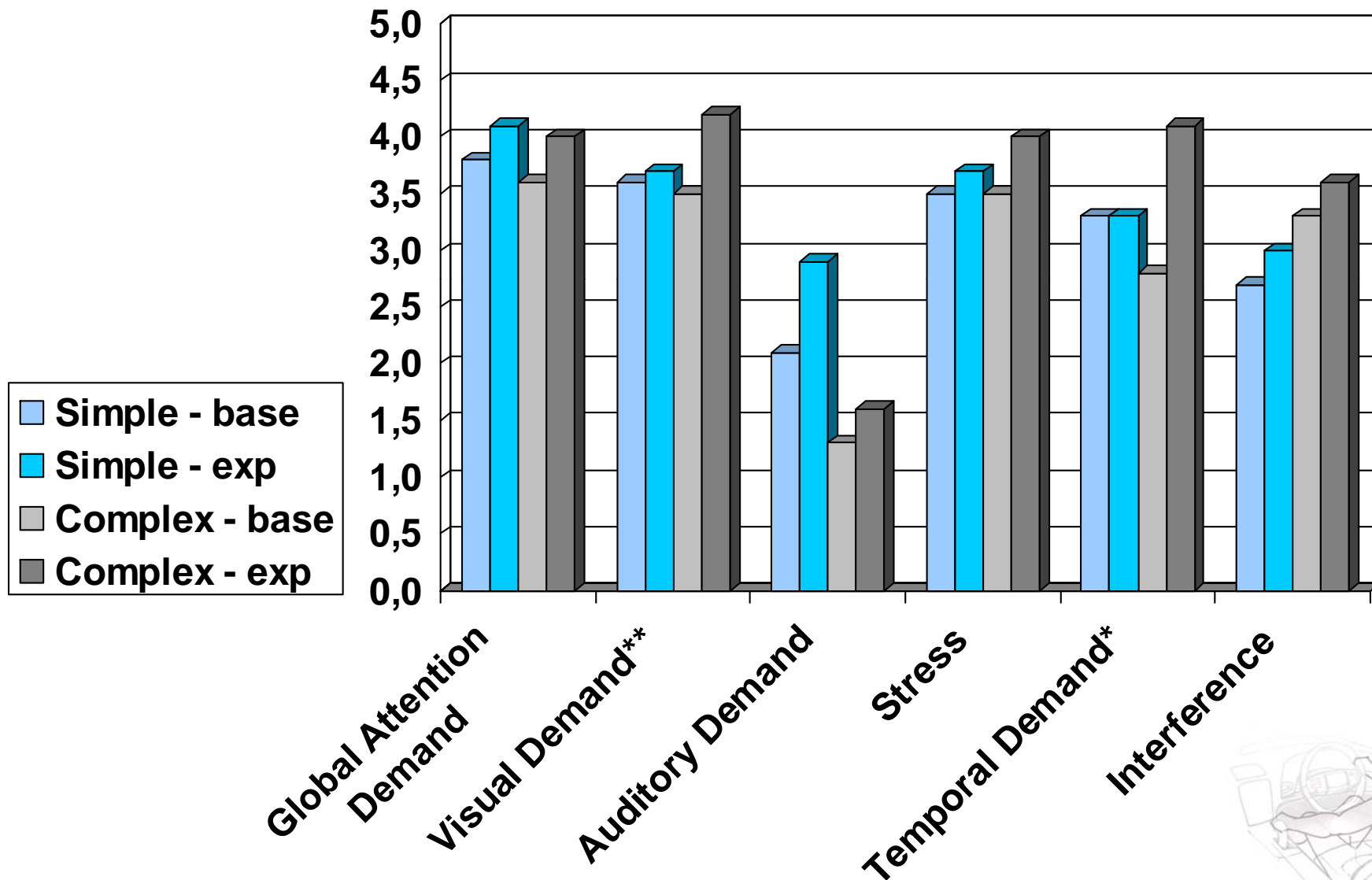


Results – Driving task

Test (Mann-Whitney)	Simple	Complex	Sig.
Time to notice	2.33	1.85	
Glance frequency	3.57	8.45	.000**
Total glance time	.75	3.44	.000*
Glance time from road	6.64	19.90	.000**
Time to reset	5.25	31.04	.000**
Lane position dev.	.329	.460	.004**
Dev from speed limit 70 zone	7.57	5.24	.033*



Results – DALI



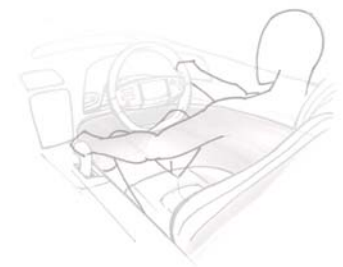
Results – DALI



<i>DALI factors</i>	Simple		Complex	
	Base	Experiment	Base	Experiment
<i>GAD</i>	3.8	4.1	3.6	4.0
<i>Visual Demand</i>	3.6	3.7	3.5	4.2**
<i>Auditory Demand</i>	2.1	2.9	1.3	1.6
<i>Stress</i>	3.5	3.7	3.5	4.0
<i>Temporal Demand</i>	3.3	3.3	2.8	4.1*
<i>Interference</i>	2.7	3.0	3.3	3.6
<i>Total</i>	3.2	3.5	3.0	3.6

* $p < .05$ ** $p < .01$

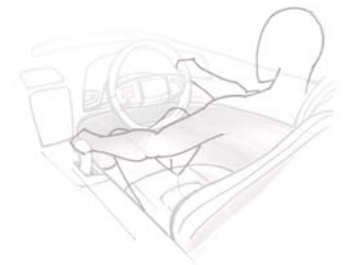
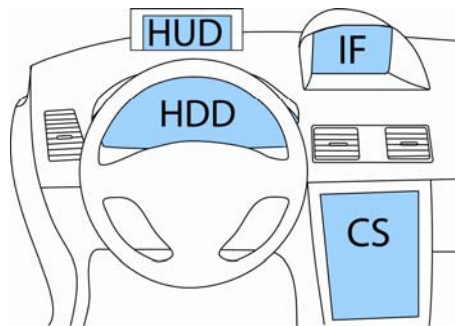
Scale: 0 low – 5 high



Results – Display Position



- 80% preferred HUD for important information
- 75% will have separation of information to different displays
- 20% wanted secondary information placed in HDD
- 2 from Simple group used HDD on 9 of 10 warnings
- All from Complex used HUD

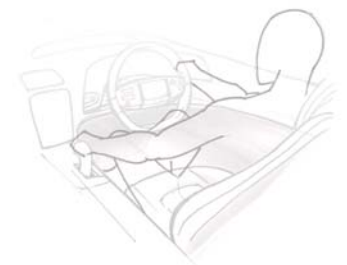
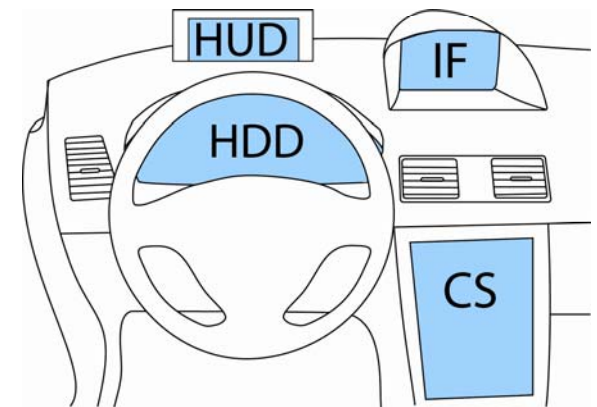


Results – Likeability and Usability Ratings

	Likeability	Usability	Total
Simple			
HUD	1.3**	1.0**	1.2**
HDD	2.5	2.5	2.5
Complex			
HUD	1.0**	1.1	1.1**
HDD	2.8	2.8	2.8

** $p < .01$

Scale: 1 *very good* – 5 *very poor*



Discussion



1. Why use different tasks in the study?

- To see if complexity effects the way the display is used
- To observe behavior before and after tasks
- To see if the HUD or HDD relevant for task information

2. Benefits of redundancy

- Driver can choose which location they are most comfortable with
- Reinforcement of information
- Less chance of “missing” a warning/message

3. Disadvantages of redundancy

- Almost everyone used the HUD
- Clutter
- More difficult to group information according to level of importance

Discussion



3. Workload

1. **Complex group showed increased Visual load & Temporal load**
 - DALI ratings explain better Lane keeping and Speed keeping
 - Needed more glances to read
2. **Simple group did not differ from Baseline**

4. Usability and Acceptance

1. High for HUD
2. Respondents used to HDD
3. Now considered HDD as “difficult” to use



Conclusions

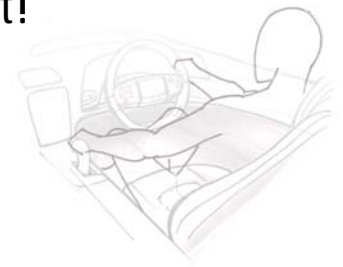


Redundancy

- Drivers used only one of the displays
- Perceived as a fancy option by some
- Unnecessary by most

HUD was advantageous

- Quicker detection
- Safer driving behavior
- Subjects preferred warnings “high up”
- HDD perceived as being a comfortable location because used to it!
- HDD preferred for non-emergency warnings



Thank you! – Questions?



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