Attention during driving: Introduction to eye tracking

HUL261: Tutorial 4

Use of eye tracking to study attention

Eye tracking technology involves tracking the movement of one's eyes (**fixations** and **saccades**) as they engage in a variety of activities.

Besides eye movement, it also allows one to measure pupil dilation, point of gaze, and blinking, to understand where people focus their visual attention- both what are the things people engage with, and what are the things they ignore.

It is a useful research tool for advertisers, UX designers, and researchers studying attention, perception, clinical disorders, among other things.

Optimizing User Experience and Advertising Research with Eye Tracking

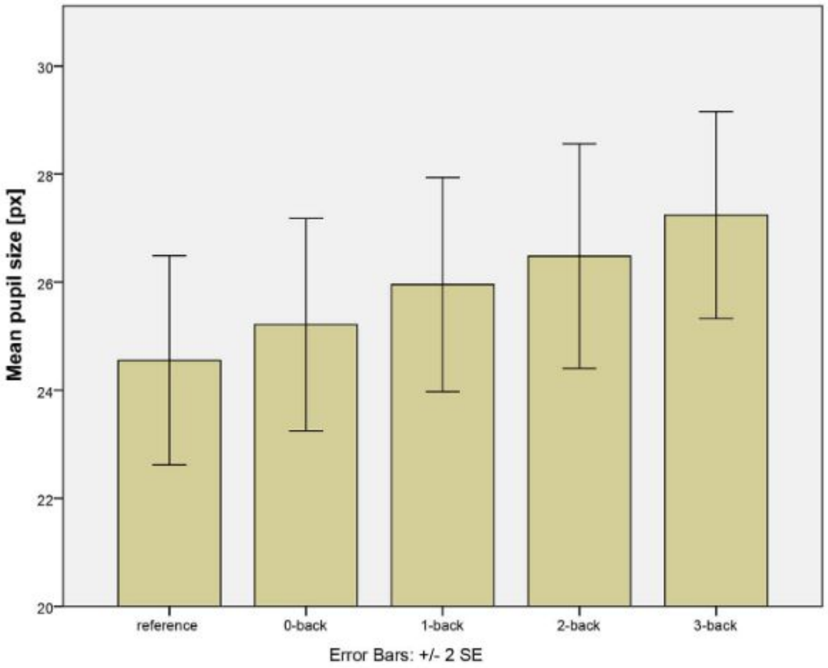
Through the eyes of an F1 driver

Attending to dynamic situations: The case of driving

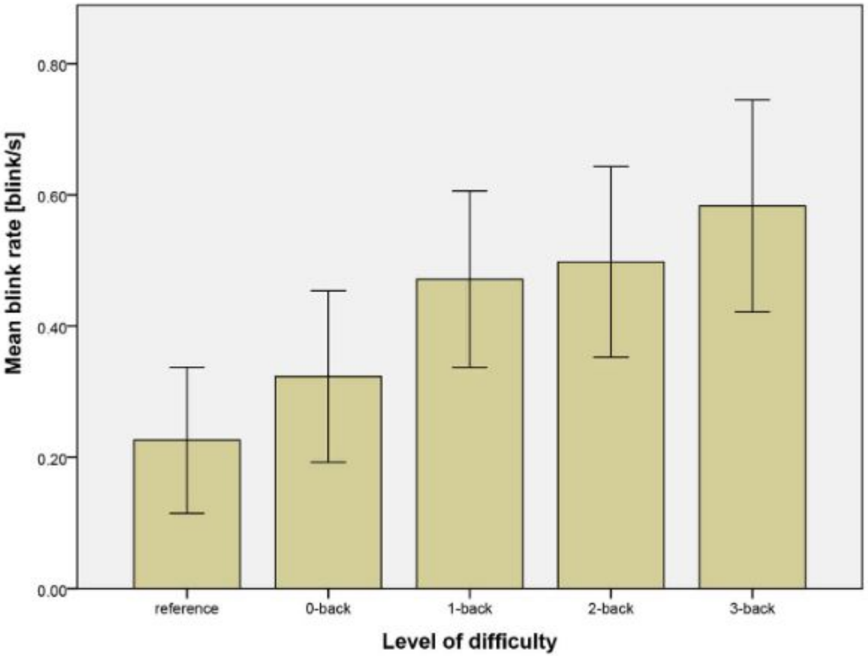
Example 1: Eye tracking, cognitive load, and driving (Čegovnik et al., 2018)

As participants engaged in simulated driving and simultaneously performed secondary tasks (*n*-back tasks) of varying cognitive complexity (0-back to 3-back), their pupil size, blink rate, and fixation time were recorded.

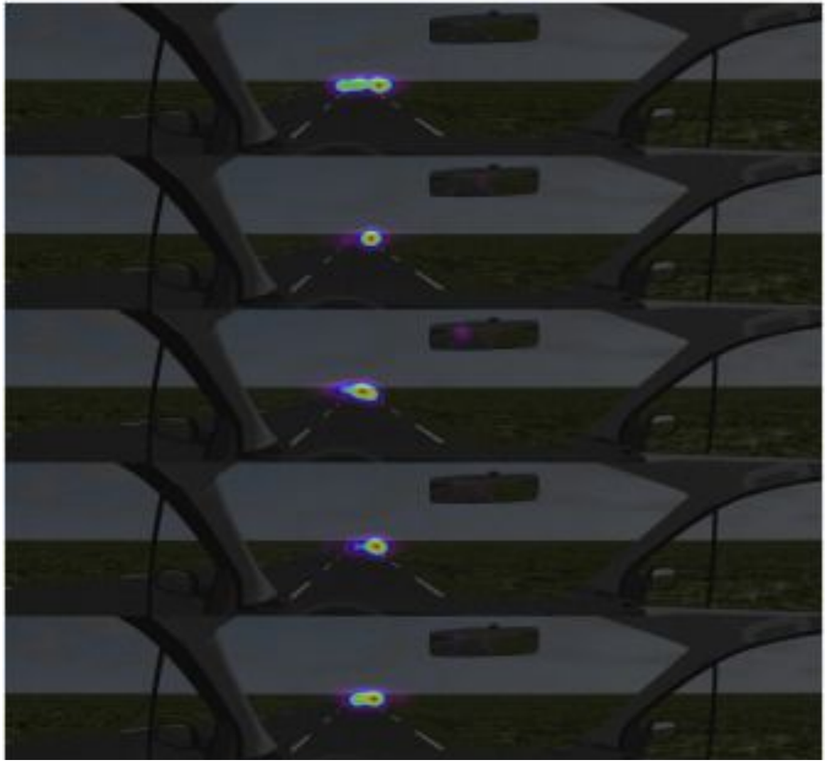
Fig. 1. Driving simulator set-up.



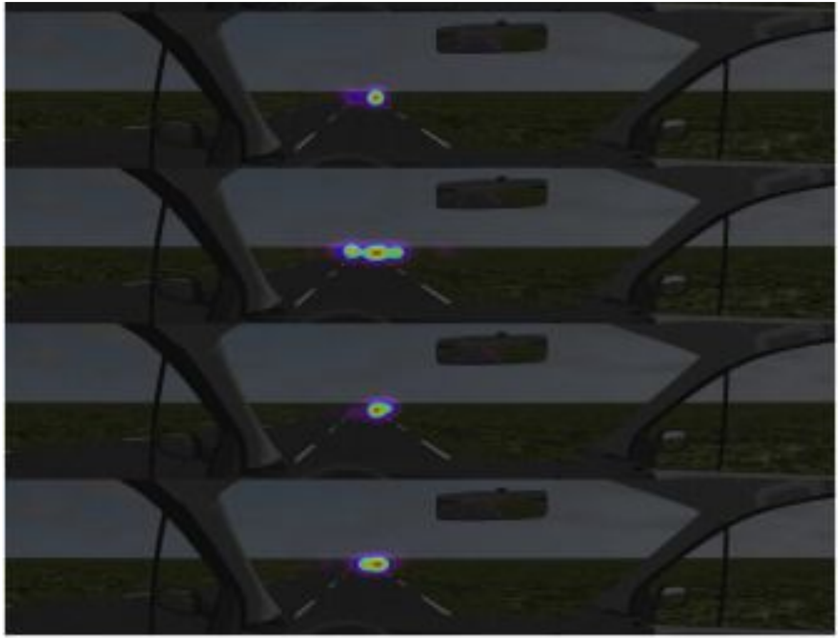
Mean pupil size [px]
30
28
26
24
22
20
reference
0-back
1-back
2-back
3-back
Error Bars: +/- 2 SE



Mean blink rate [blink/s]
0.80
0.60
0.40
0.20
0.00
reference
0-back
1-back
2-back
3-back
Level of difficulty



Phases 1 to 5



Phases 6 to 9

Tunnel vision in cognitively demanding tasks (notice phase 8, the 3-back task phase)

But we don’t perform tasks like these while driving in our everyday life.

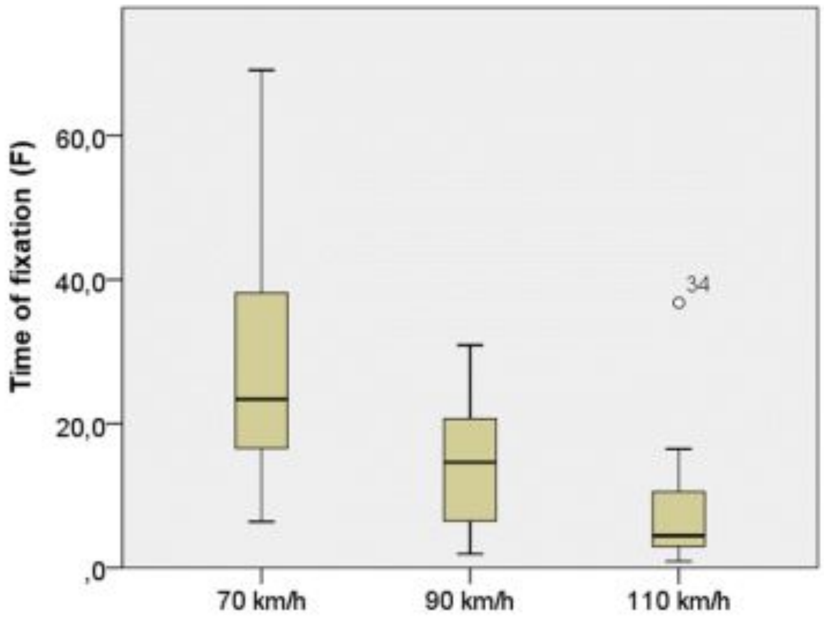
Then, a more “realistic” factor relevant to daily driving could be the **speed** at which one is driving.

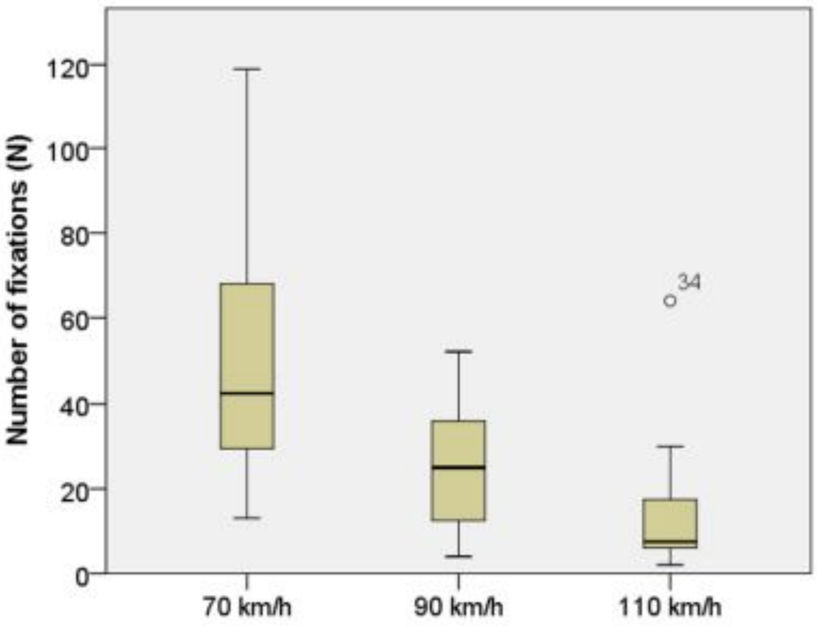
Example 2: Speed and visual attention while driving (Buzon et al., 2021)

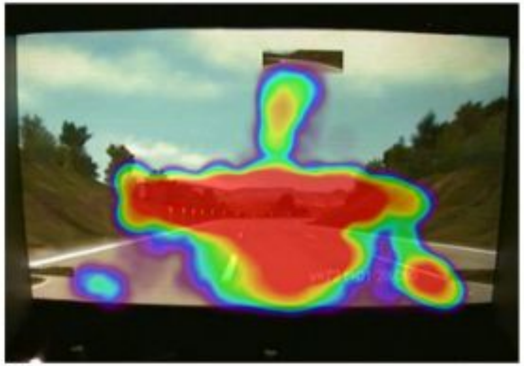
Buzon and colleagues investigated the influence of vehicle speed on driver’s visual attention. They measured drivers’ eye movements (time of fixation, number of fixations, mean fixation) at three different speeds (70 km/hr, 90 km/hr, 110 km/hr).

- Recall and identify IV(s) and DV(s).

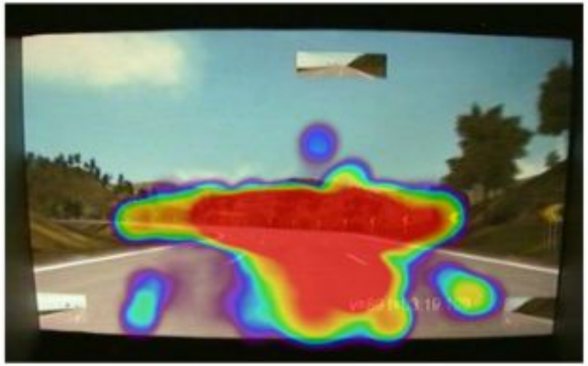
(a) Eye tracking system


Time of fixation (F)
60,0
40,0
20,0
,0
34
70 km/h
90 km/h
110 km/h

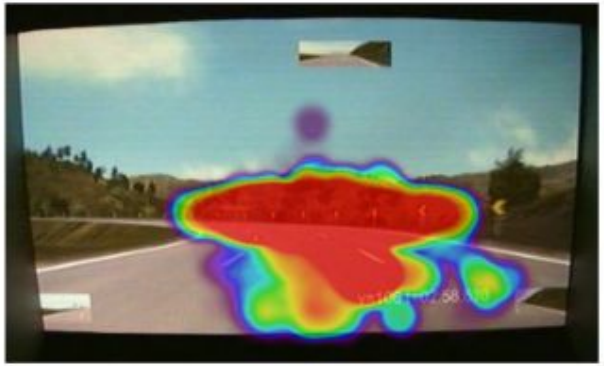

Number of fixations (N)
120
100
80
60
40
20
0
34
70 km/h
90 km/h
110 km/h



(a) 70 km/h



(b) 90 km/h



(c) 110 km/h

How does eye tracking help us in daily life? Let’s look at an **industry application**.

<u>Example 3: SEAT’s eye tracking study to enhance safety while driving (tobiipro.com, 2022)</u>

- Wanted to study the impact that their cars’ infotainment systems have on drivers’ awareness and attention.
- Such systems have the potential to draw away drivers’ attention and thereby reduce safe driving.
- SEAT researchers used eye tracking technology to identify where drivers intuitively expected to find important information.
- The obtained data was used to re-design screens such that information was displayed where people naturally searched for it: reduces search time, increases safety.

Related concepts

Looking, but not seeing: **inattentional blindness**

selective attention test

Strayer and colleagues (2003) examined the effects of engaging in cell phone conversations on simulated driving. They used eye movement data to identify which aspects of the driving environment participants fixated on and if recognition memory was better for these aspects. Surprisingly, participants engaged in phone conversations were less likely to remember even those billboards that their eyes had indeed “looked” at (Experiment 3).

Examples from daily life?

Figure 8 A representation of what a driver might perceive when they are not talking on the phone (left panel) and when they are talking on a hands-free cell phone (right panel).

Related concepts

Divided attention

We seem to believe we can juggle two tasks simultaneously. But can we?

- Limited cognitive capacity
- Cognitive load

Can we **practice** our way out of the interference caused by using cell phones?

- Real-world experts and novices at taking calls while driving show no difference in their ability to multitask (Strayer et al., 2011).
- Simulated practice with predictable events leads to safer driving but the benefits of practice do not transfer to novel situations (Strayer et al., 2011).

- But tasks that are practiced so much that they become “automatic” can be engaged in without performance on them being impacted by multitasking. This, however, happens with very simple tasks in highly practiced situations (Wood & Zivcakova, 2015).

Why not with driving while being on a call? (Strayer et al., 2011)

- Environmental consistency is important for practice to be effective.
- Both driving and phone conversations lack this consistency.
- Driving involves reacting to unexpected events (e.g., sudden appearance of a pedestrian in front of your car).
- Phone conversations can be of different kinds (e.g., a casual conversation catching up with a friend versus a heated business-related call).

Explore by yourself!

Audi’s eye tracking study to understand “driving without awareness”: Eye tracking for driver safety

Fang You and colleagues’ (2017) study analyzing gaze data to inform ideal design of information systems in cars: Using Eye-Tracking to Help Design HUD-Based Safety Indicators for Lane Changes

References

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Image sources

Slides 3, 4, 5: Čegovnik, T., Stojmenova, K., Jakus, G., & Sodnik, J. (2018). An analysis of the suitability of a low-cost eye tracker for assessing the cognitive load of drivers. *Applied ergonomics*, *68*, 1-11. https://doi.org/10.1016/j.apergo.2017.10.011

Slides 6, 7, 8: Buzon, L. G., Figueira, A. C., Larocca, A. P. C., & Oliveira, P. T. (2021). Effect of Speed on Driver's Visual Attention: A Study Using a Driving Simulator. *Transportation in developing economies*, *8*(1), 1-11. https://doi.org/10.1007/s40890-021-00139-y

Slide 11: Strayer, D. L., Watson, J. M., & Drews, F. A. (2011). Cognitive Distraction While Multitasking in the Automobile. In B. Ross (Ed.), *The Psychology of Learning and Motivation* (pp. 29-58). Burlington: Academic Press.