

The Influence of Light-induced Dynamics

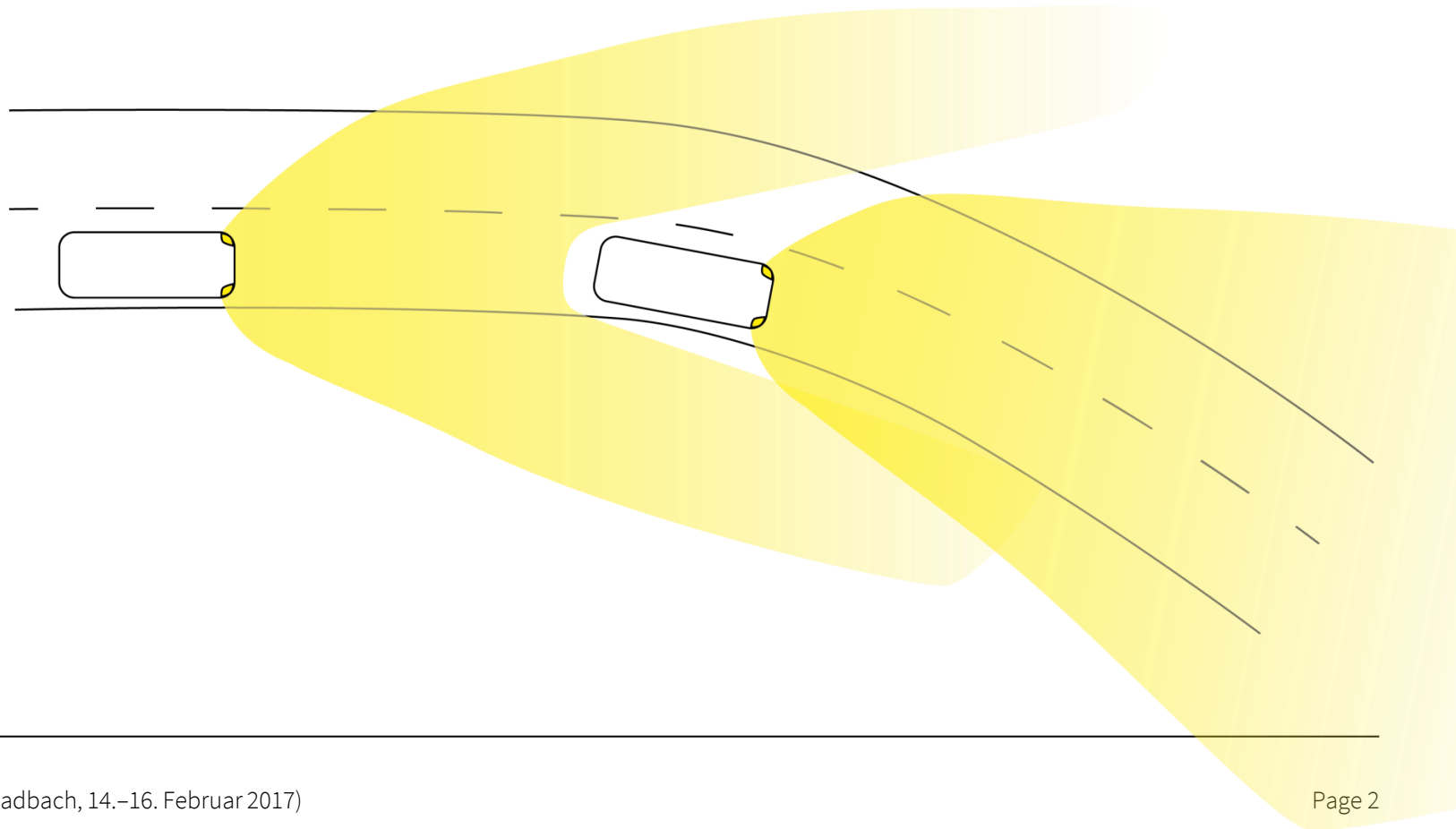
on Attention, Perception, and Driving Behavior

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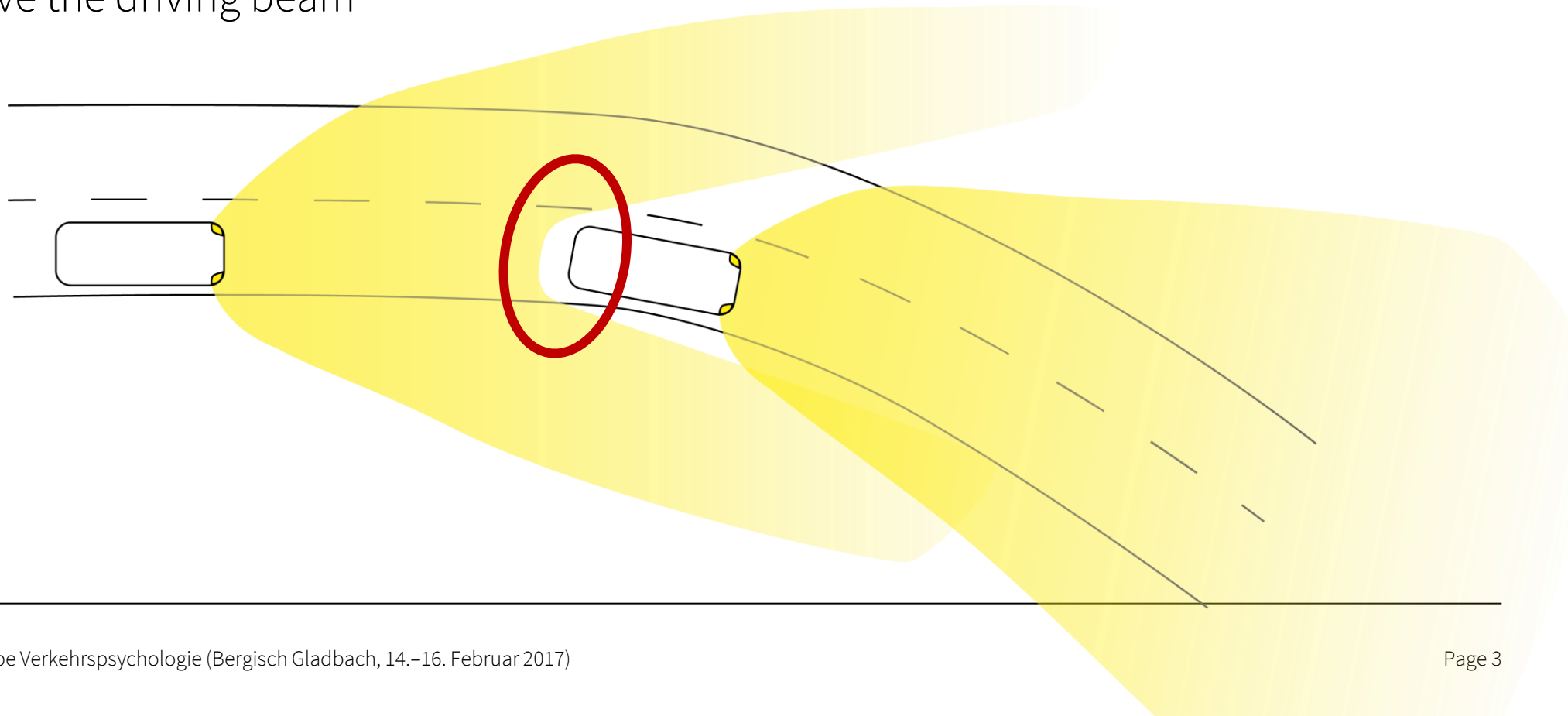
Adaptive Car Lighting Systems

- Optimally illuminated field of view
 - in every driving situation
 - without glaring other road users



Changing Light Patterns

- caused by adaptive the driving beam

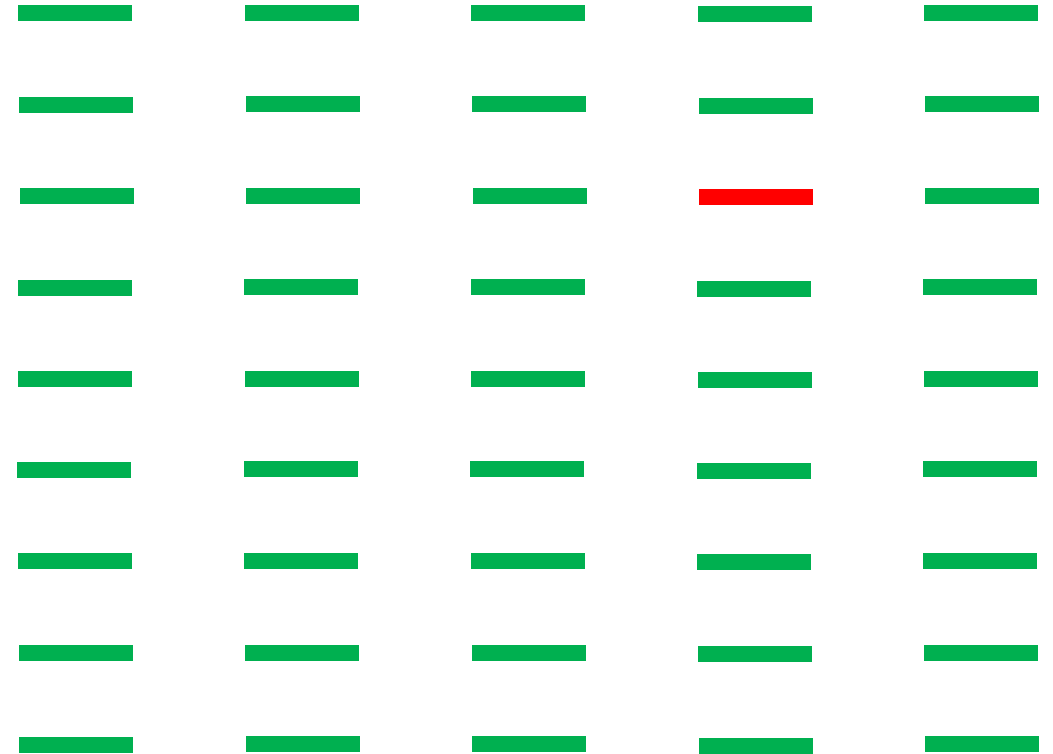


Adaptive Light Beam in Action

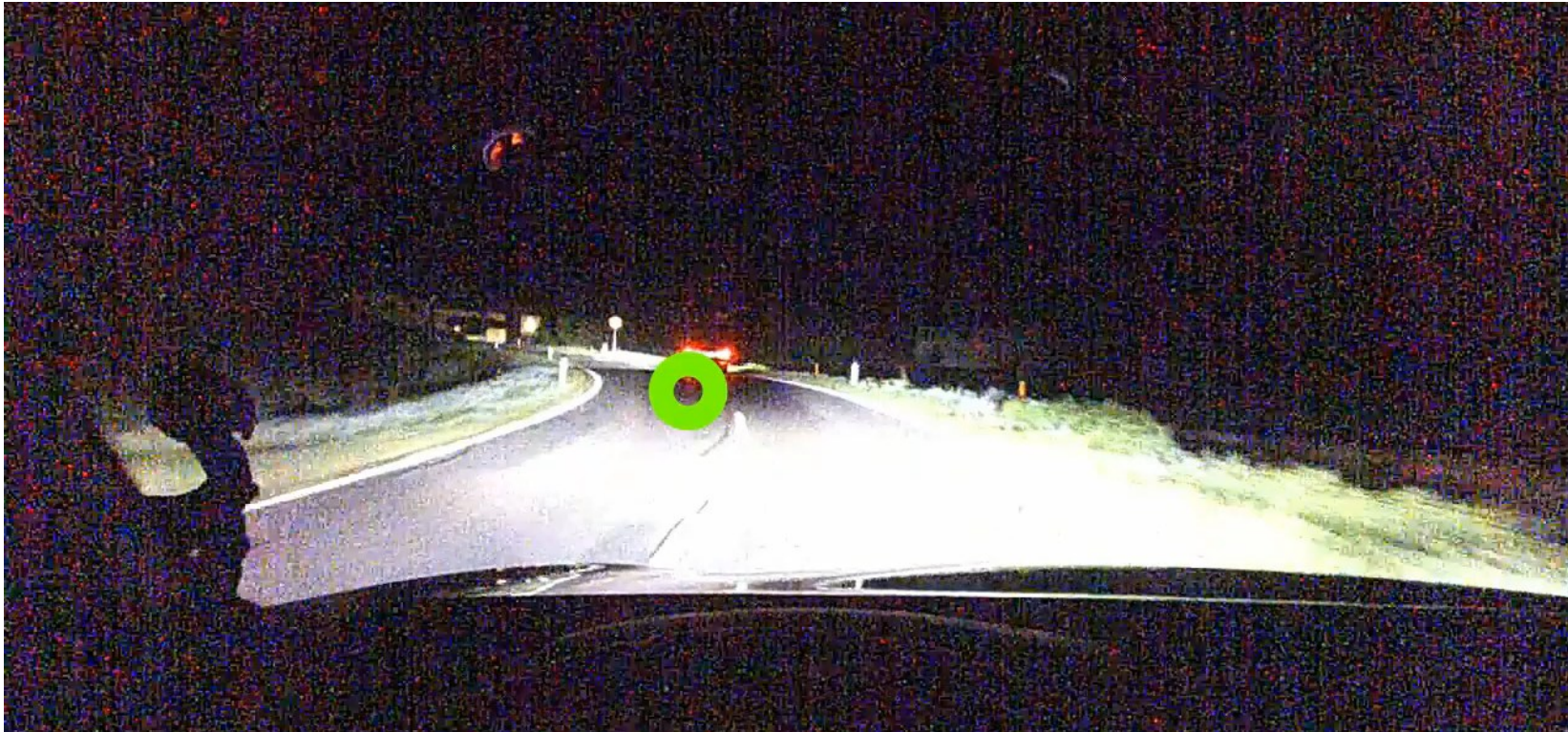


Why is it important?

- Dynamic stimuli...
(visual stimulus features changing over time)
- ...may attract visual attention...
(selective processing of stimulus features or locations)
- ...because they are salient.
(conspicuous compared to there surroundings)



Visual Attention During Driving



Dynamics During Driving

- caused by moving objects (object-induced)
 - very relevant → attract attention
- caused by own motion (motion-induced)
 - less relevant + predictable
- **light-induced dynamics**
 - NOT caused by moving objects
 - BUT different from motion-induced dynamics
 - no strict correlation with self-motion
 - less predictable



Are light-induced dynamics...
...more like object-induced dynamics or
...more like motion-induced dynamics?

Open Question: Are light-induced dynamics detrimental to driving safety?

- Research on car lighting is complex, but necessary

Nevertheless, the difficulty of experiments and studies on the influence of vehicle lighting on road safety, even when the devices considered are “classical” lamps, evidences that **research on AFS will be a complex task whose results will give us many surprises.**

In summary, **deep studies on the impact of AFS on safety are extremely necessary and** will let carmakers and headlamps manufacturers learn important lessons before these systems become massively mounted in cars all over the world. The target of this

Peña-García, A., Peña, P., Espín, A., & Aznar, F. (2012). Impact of Adaptive Front-Lighting Systems (AFS) on Road Safety: Evidences and Open Points. *Safety Science*, 50(4), 945–949. <https://doi.org/10.1016/j.ssci.2011.10.013>

Pilot Study: Influence of Light-Induced Dynamics on Eye Movements?

- two headlamp settings (prototypes from ZKW Group GmbH)
 - pronounced vs. subtle light-induced dynamics
- curvy roads with preceding car
 - these situation elicit the light-induced dynamics
- Within-subject design
 - each participant drove with both headlamp settings on different roads
- head-mounted eye tracker

Scene Selection

- scenes should differ only in the amount of light-induced dynamics
 - not easy in real-world setting



pronounced dynamics



subtle dynamics

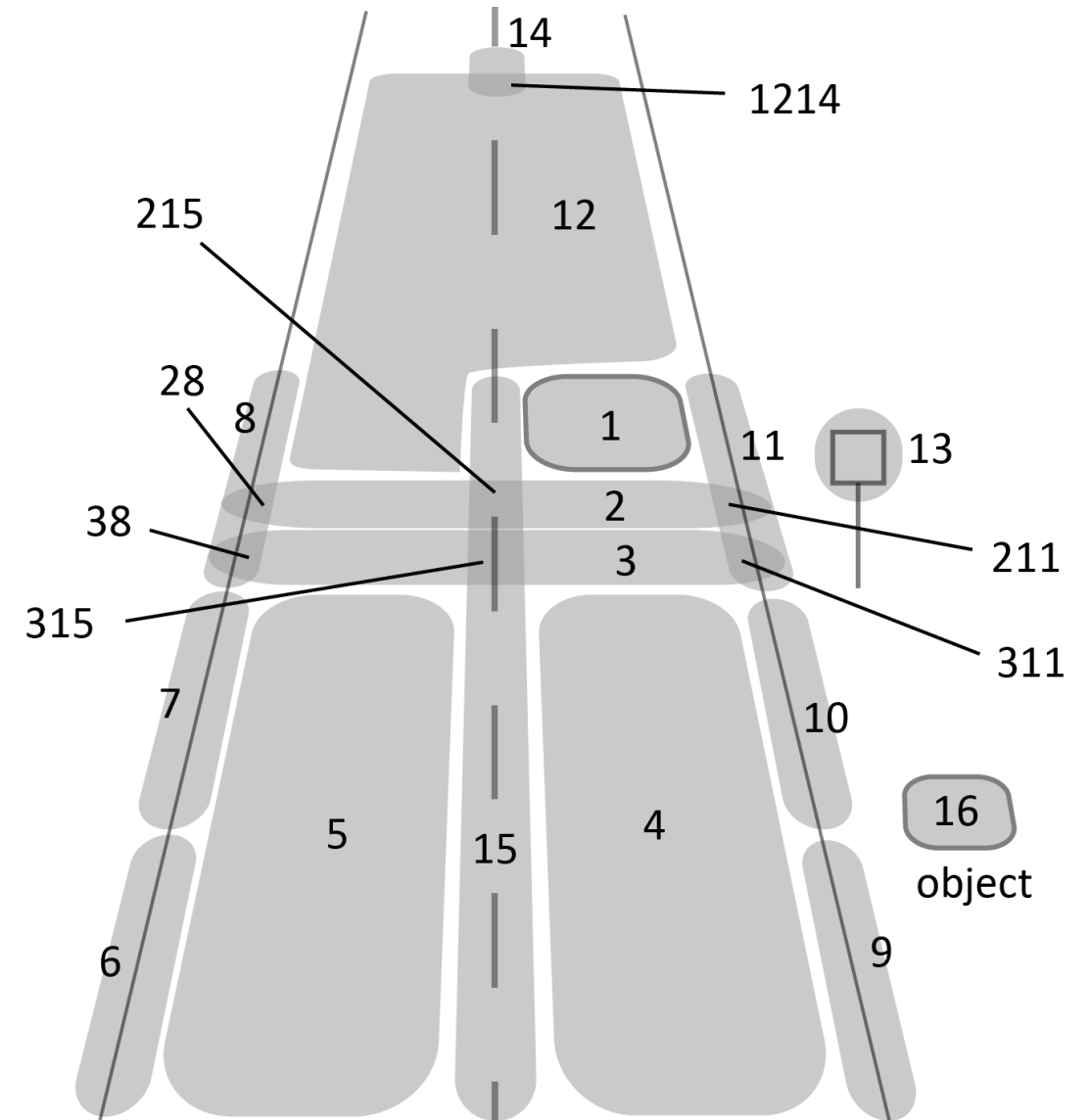
The Pitfalls of Analyzing Real-World Eye Tracking Data

- we had a lot of smooth pursuit eye movements
 - dynamic scenes, preceding car
- software failed to detect smooth pursuits
 - actually excluded these data
- head movements may produce data patterns that look like smooth pursuit, but are not
- solution: manual analysis of gaze-overlay video



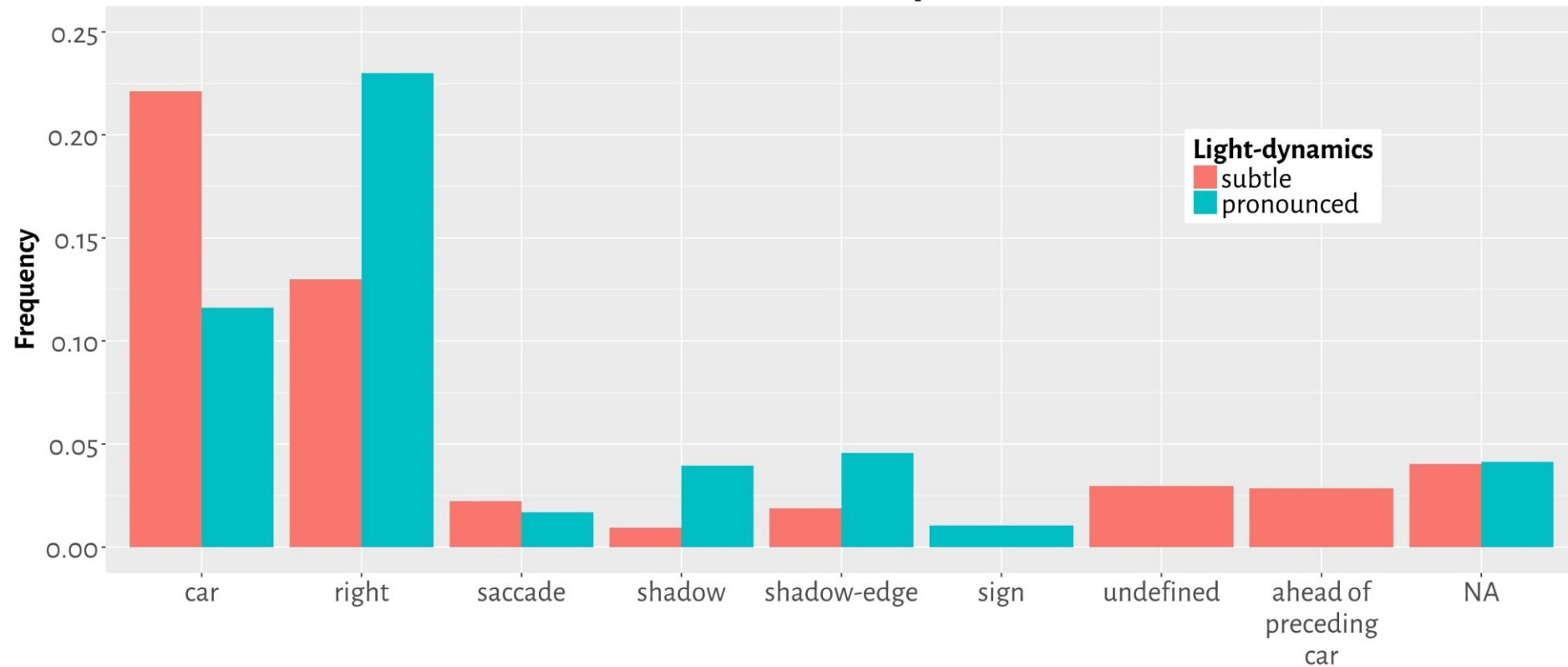
Manual Semantic Coding

- labeling gaze position in each frame
- codes for areas and objects
 - 1 = preceding car
 - 2 = shadow area, 3 = shadow edge
 - 211, 311, 28, 38 etc. = overlapping areas
 - 14 = point of expansion



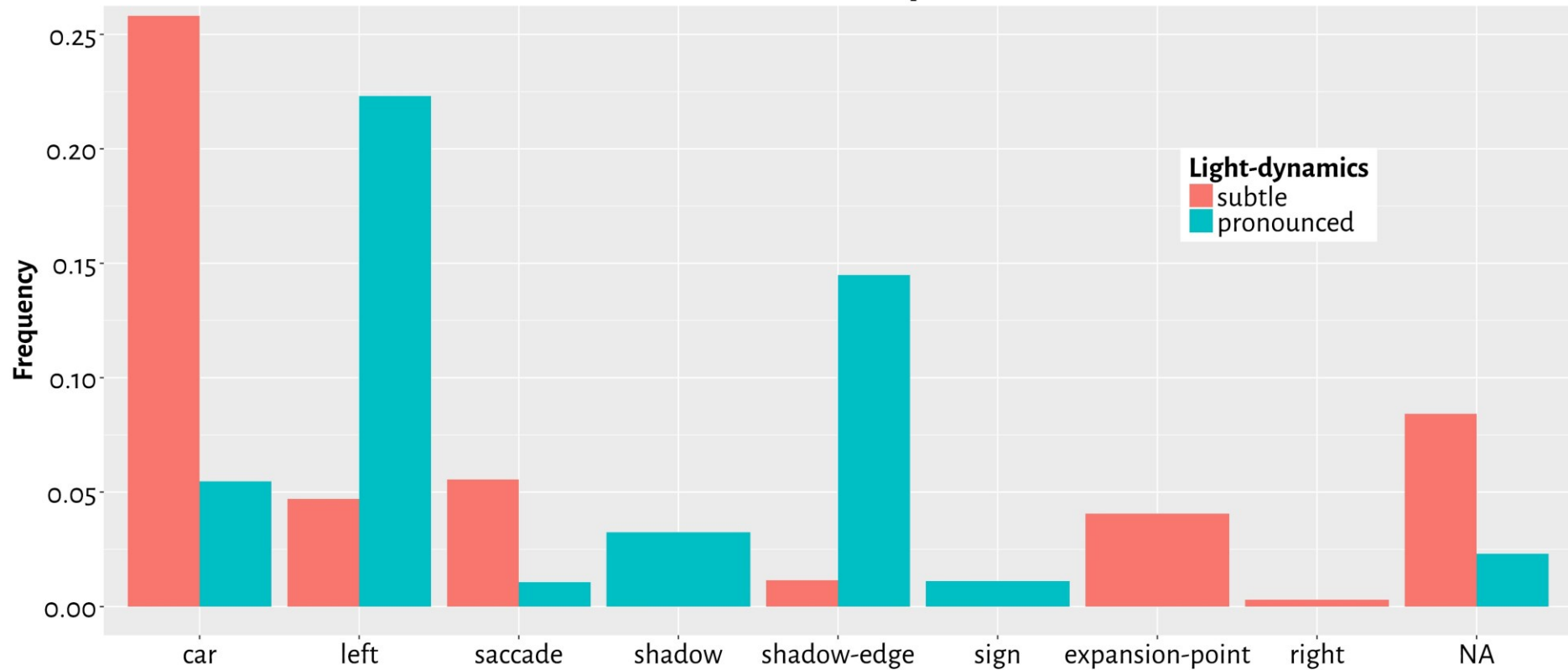
Gaze Dwell Time Distribution

Gaze distribution person 83



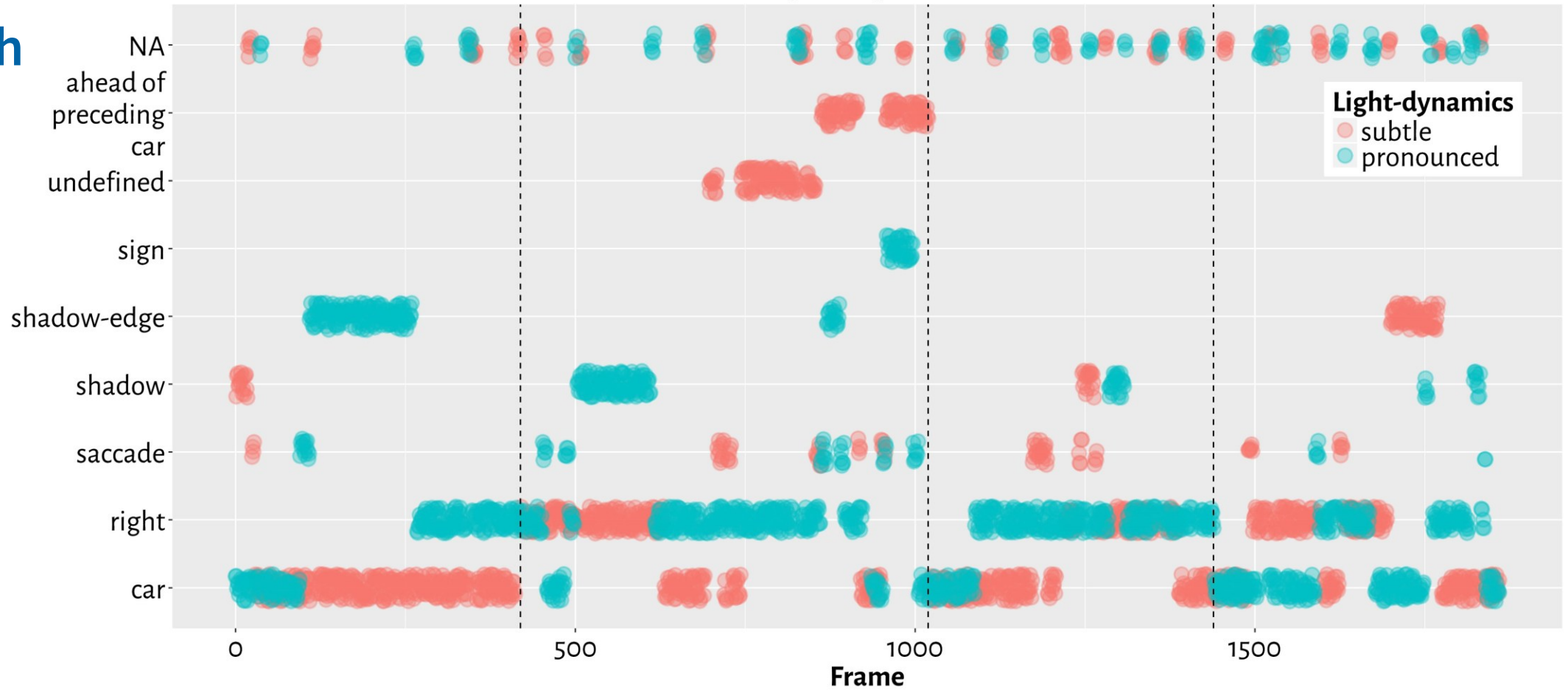
Gaze Dwell Time Distribution

Gaze distribution person 96

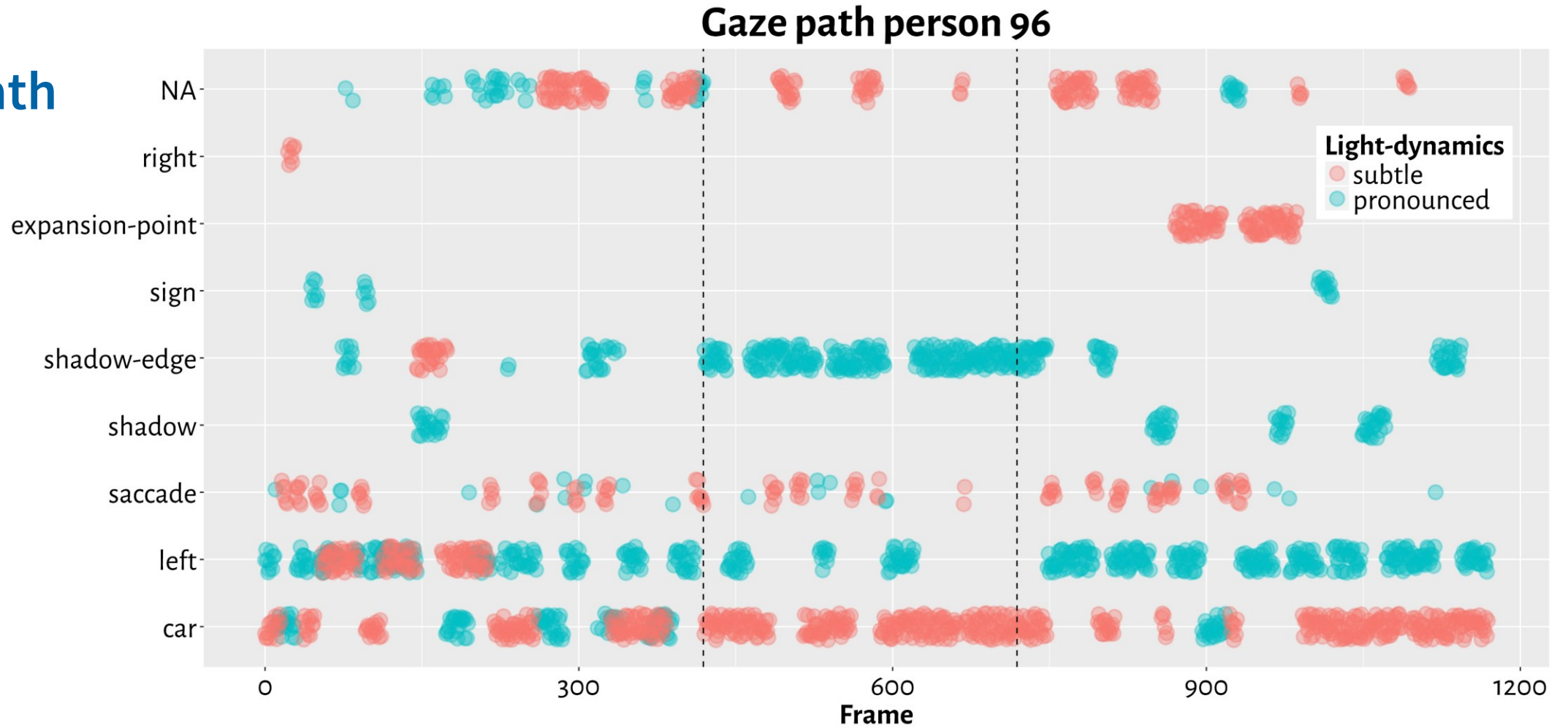


Gaze Path

Gaze path person 83

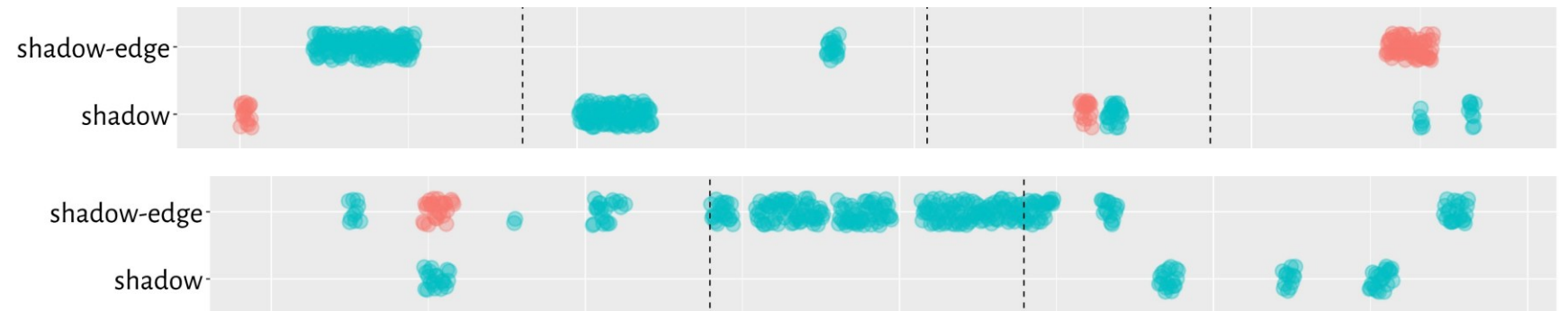
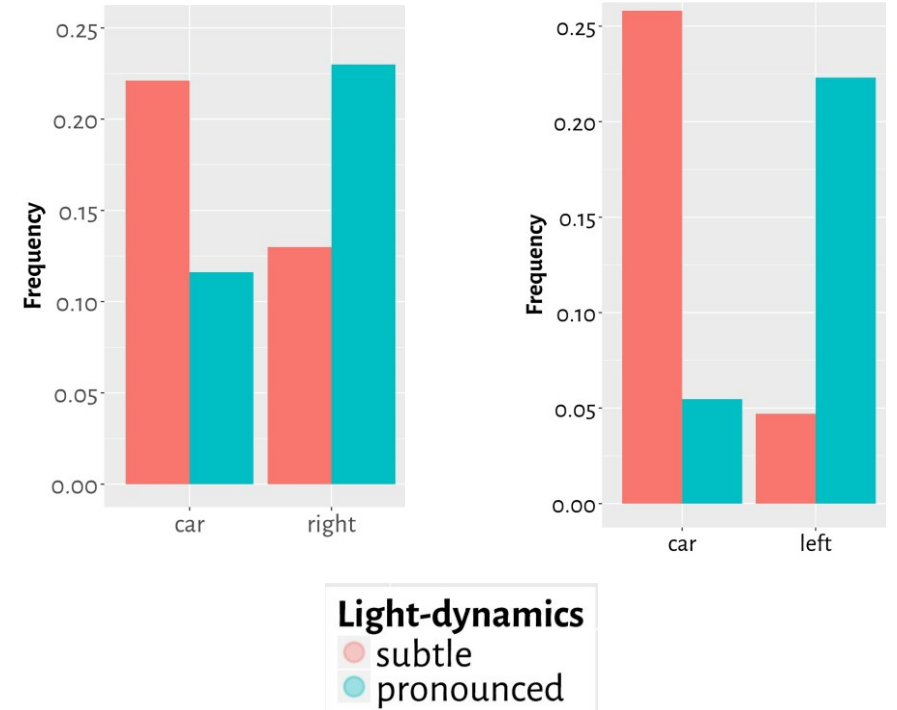


Gaze Path



First Descriptive Results

- Gaze behavior is task-dependent
 - lane keeping
 - keeping a distance to preceding traffic
- Light-induced dynamics influenced eye movements



Next Questions

- Is the observed influence detrimental to driving safety?
 - influence on attention, object detection etc.
- Are there interindividual differences?
 - effect of familiarity with specific headlamp used, experience, age etc.
- How should car lighting systems be designed to avoid adverse effects?
 - effect of specific light characteristics (moving shadows etc.)



Thank you for your attention

- ...and thanks to my team
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 - Christian Büsel
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