EMPIRICAL EVALUATION OF DEMANDS IMPOSED ON DRIVERS BY CHARACTERISTICS OF DYNAMIC VISUAL INFORMATION

Sebastian Gary[1], Nadja Schömig[1], Dennis Befelein[1], Alexandra Neukum[1], Klaus Perlet[2], & Sebastian Hergeth[2]

[1)] Wuerzburg Institute for Traffic Sciences (WIVW GmbH)

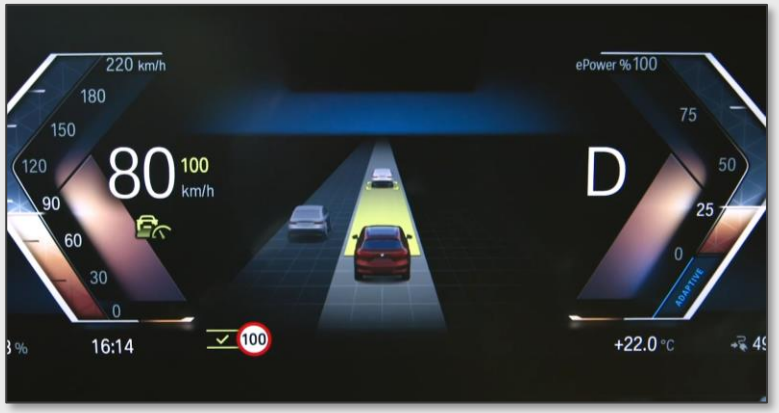
[2)] BMW Group

9th International Conference on Driver Distraction and Inattention
Ann Arbor, Michigan, 22.10.2024

WIVW

MOTIVATION

- Trend: use of **animations** in in-vehicle HMIs for both **driving-related** and **non-driving-related** functions
  - Animations = dynamic visual information
  - E.g., extension, position in space, shape, possible texture, color, transparency
- Risk: Driver Diverted Attention (DDA; Regan et al., 2011):
  - Voluntary DDA : Deliberate (top-down) direction to stimulus
  - Involuntary DDA: Reflexive (bottom-up) diversion away from activities critical for save driving
- Impact of animations on driver attention depending on **duration** and **design characteristics**.
  - Abrupt onsets, looming, as well as concurrent changes in luminance contrast and contrast polarity can lead to attention capture (Franconeri & Simons, 2003)



Animated vehicle environment and driver assistance, BMW

HYPOTHESES & METHODS

HYPOTHESES & STUDY DESIGN

- Hypotheses:
  - H1: Animation duration affects driver eyes-off-road times.
  - H2: Animations with specific design features can initiate involuntary DDA.
  - H3: Effects of animations on driver eyes-off-road times change over time.
- Study design: 2x2x3-witihin-subect design
  - Factor 1: Duration (2 s vs. 20 s.)
  - Factor 2: Attention capturing properties (containing vs. not containing)
  - Factor 3: Time of measurement (first vs. second vs. third)
- n = 21 participants
- Dependent variables
  - Glance behavior
  - Reaction times in vDRT
  - Subjective ratings

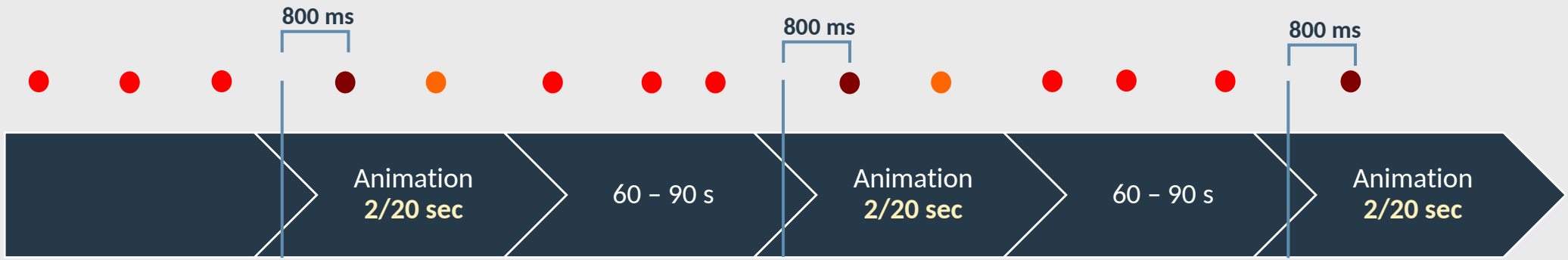
Driving simulator at WIVW

METHODS

HOW TO OPERATIONALIZE INVOLUNTARY DISTRACTION?

- Instruction:
  - Car follow driving task
  - Performing DRT possibly without missing any DRT point

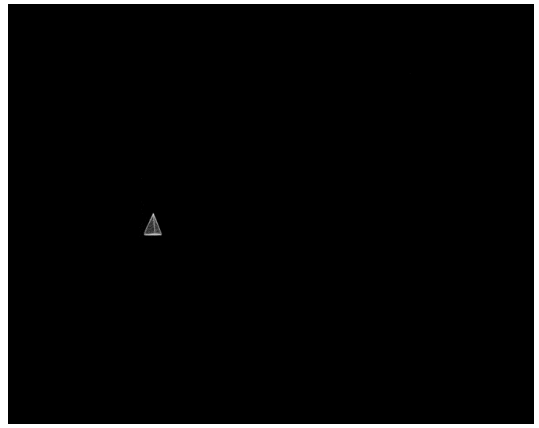
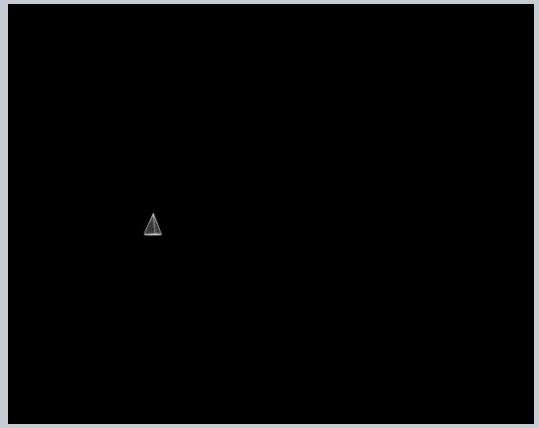
- DRT (ISO-Norm 17488:2016) with **modification:**
  - timed presentation: DRT dot presented exactly 800 ms after animation onset (timed DRT dots), analyzed separately from
  - the other DRT dots (continuous DRT dots) and
  - baseline DRT dots



METHODS

STIMULUS MATERIAL

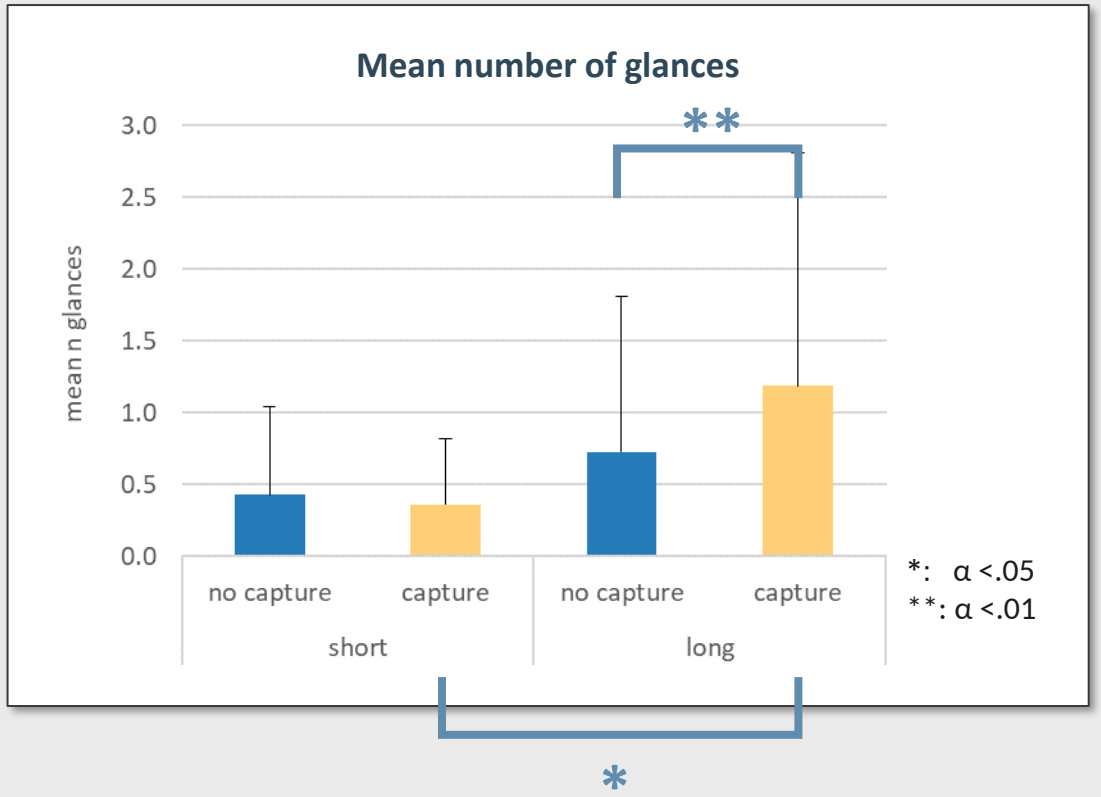
HOW DO THE ANIMATIONS LOOK LIKE?

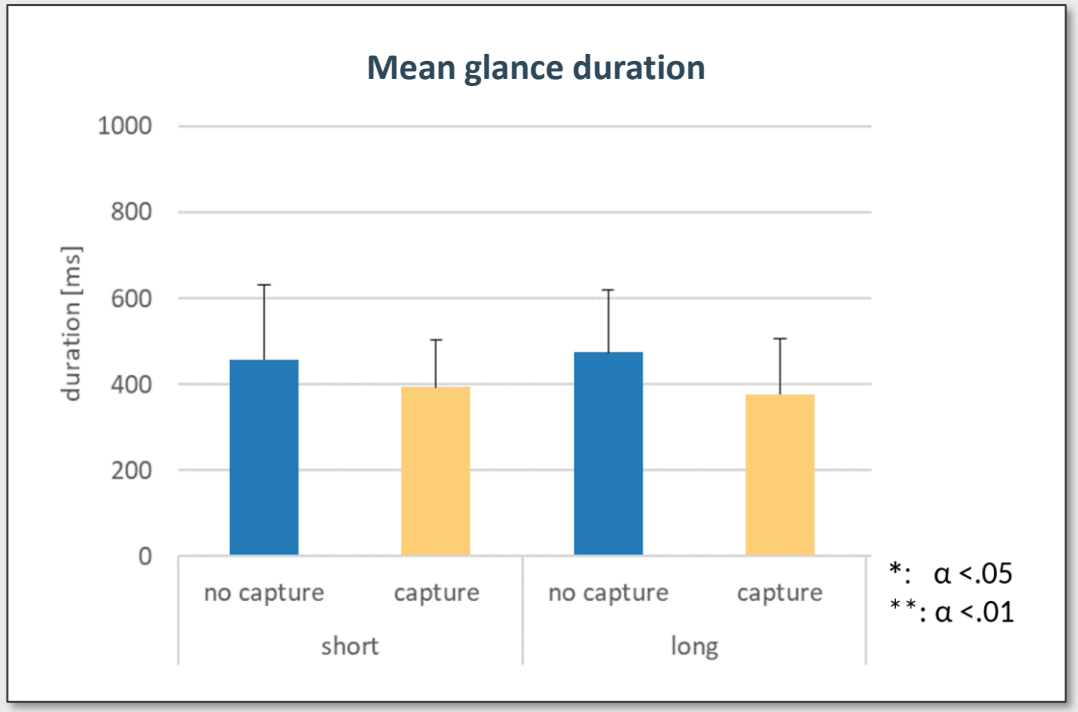
		Animation design	
		No Attention Capture Features	Attention Capture Features
Animation duration (within)	Short Duration (2 s)		
	Long Duration (20 s)		

RESULTS

RESULTS – GLANCE DATA

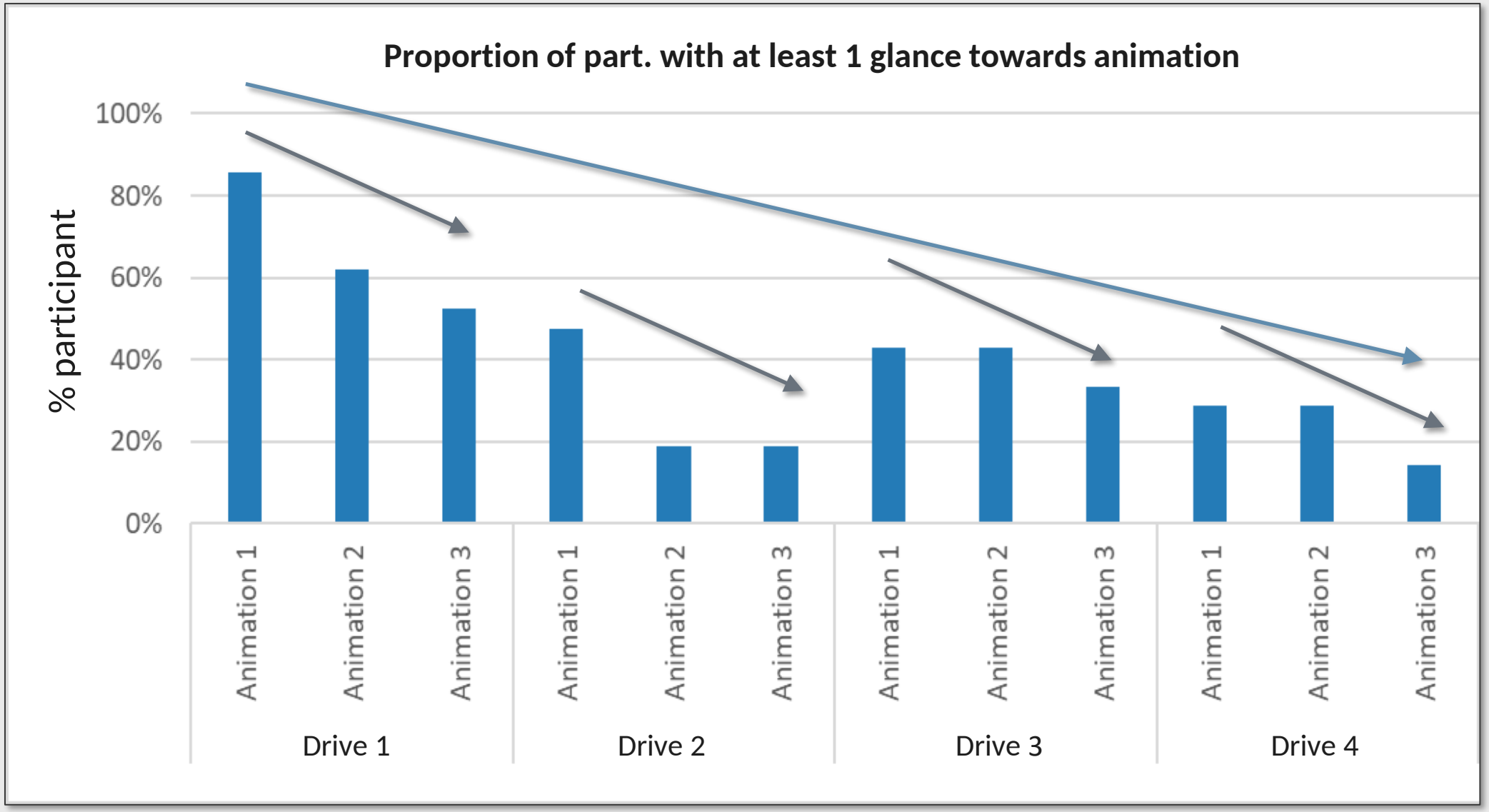
HOW DID THE ANIMATIONS AFFECT GLANCE BEHAVIOR?





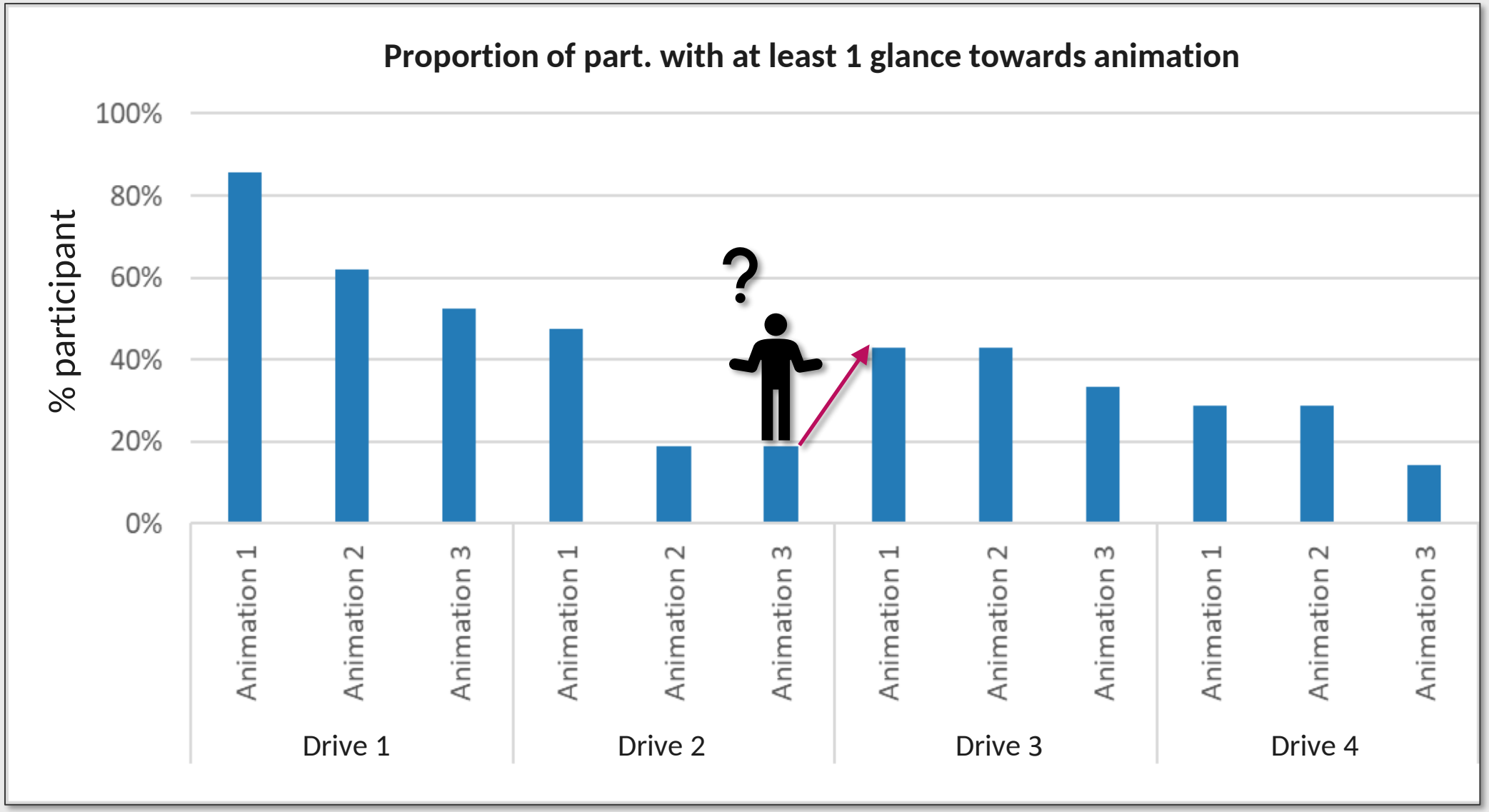
RESULTS – GLANCE DATA

HOW DID GLANCE BEHAVIOR CHANGED OVER TIME?



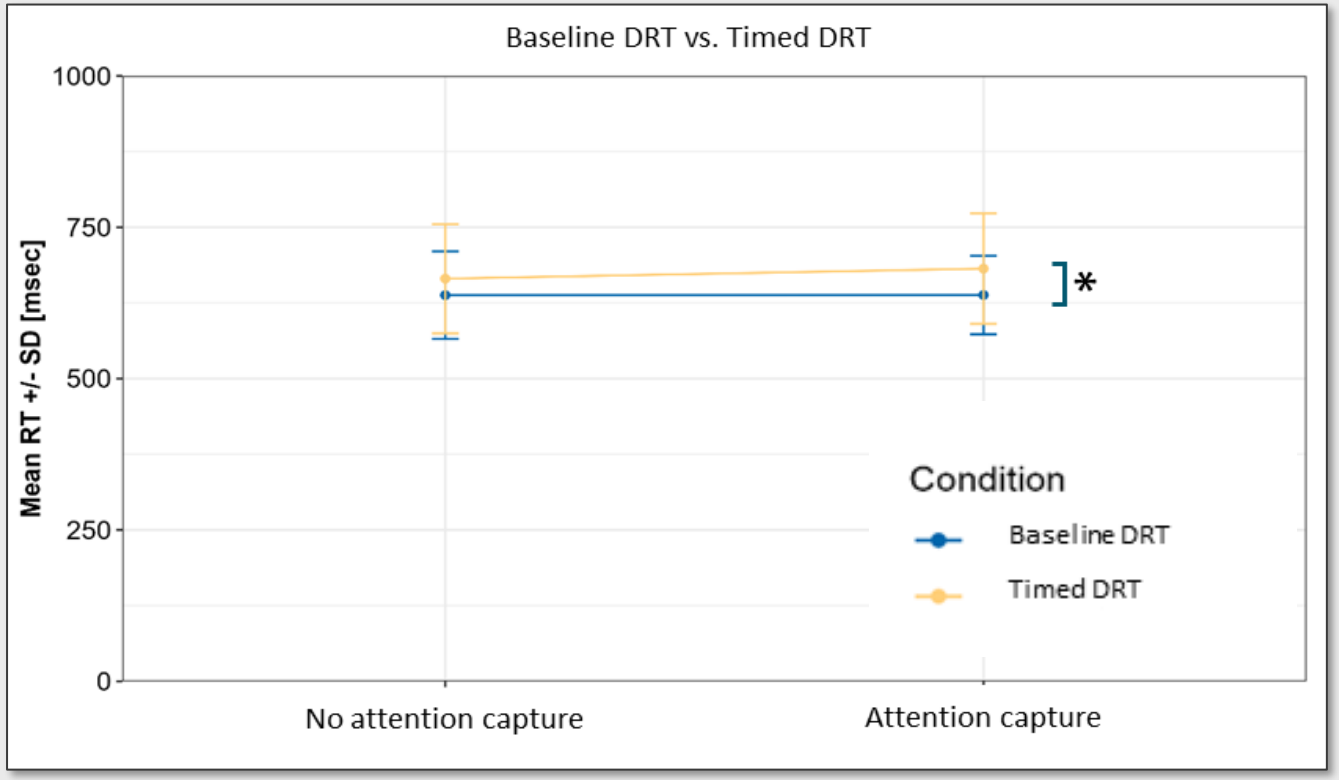
RESULTS – GLANCE DATA

HOW DID GLANCE BEHAVIOR CHANGED OVER TIME?

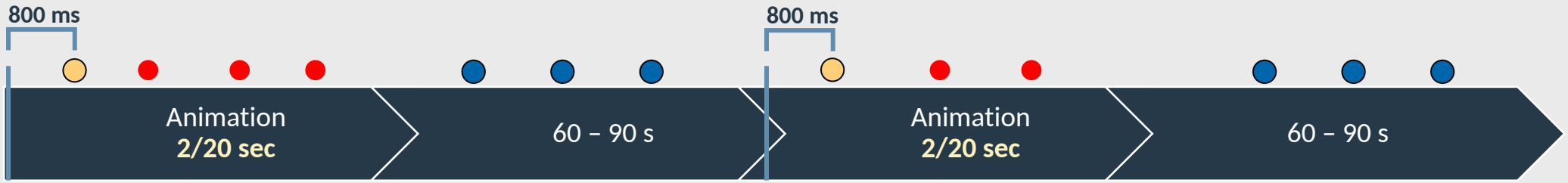


RESULTS - VDRT

HOW DID THE ONSET AND PRESENCE OF ANIMATIONS AFFECT REACTION TIME TO DRT?

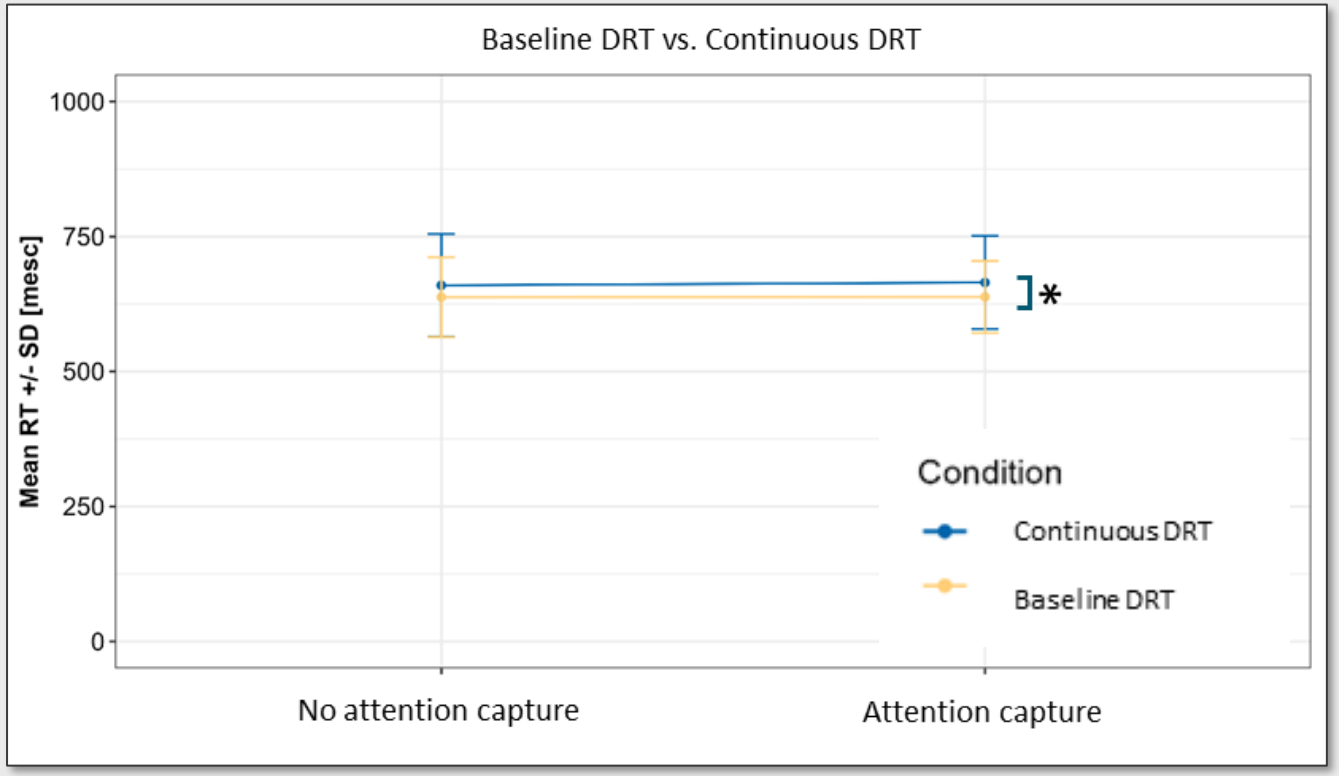


- Higher RT in **timed** compared to **baseline** (i.e., without animation) vDRT

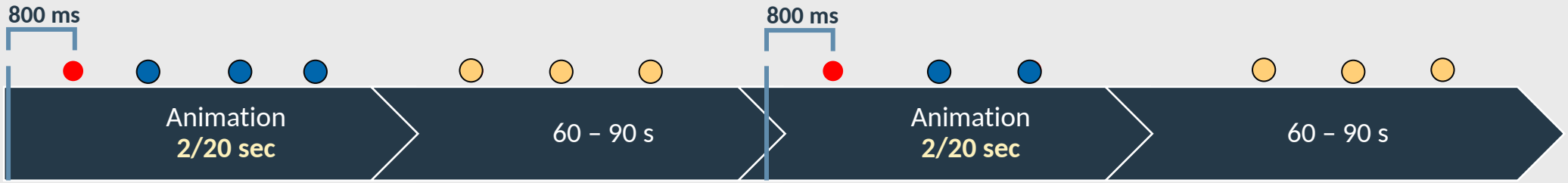


RESULTS - VDRT

HOW DID THE ONSET AND PRESENCE OF ANIMATIONS AFFECT REACTION TIME TO DRT?



- Higher RT in timed compared to baseline (i.e., without animation) vDRT
- Higher RT for **continuous** compared to **baseline** vDRT
- But: Absolute differences are small.
- Not in Figure
  - No significant effect of animation duration and design features on timed vDRT.
  - Missings extremely rare and not sensitive.



DISCUSSION & CONCLUSION

Discussion & Conclusion

Participants: motivated to perform well in DRT

- Nevertheless, the majority looks at the animations at least once
- Instruction worked: Involuntary distraction was created

Gaze frequency increased with long animations, especially with attention capture features.

- Probability of repeated involuntary gazes is connected with animation duration

Strong habituation effect

- But: Overlaid by novelty

Reaction times with animation longer compared to baseline, independent of features

- Presence of animation affects attention behavior
- But: very small RT impairment
- uncritical with regard to driving safety

THANK YOU FOR YOUR ATTENTION!

Würzburger Institut für Verkehrswissenschaften GmbH

Robert-Bosch-Straße 4
D-97209 Veitshöchheim
Germany
www.wivw.de

Sebastian Gary
gary@wivw.de

REFERENCES

- Franconeri, S. L., & Simons, D. J. (2003). Moving and looming stimuli capture attention. *Perception & psychophysics*, *65*(7), 999-1010.
- Regan, M. A., Hallett, C., & Gordon, C. P. (2011). Driver distraction and driver inattention: Definition, relationship and taxonomy. *Accident Analysis & Prevention*, *43*(5), 1771-1781.
- Schilbach, J. (2014, August). An event-based framework for animations in X3D. In *Proceedings of the 19th International ACM Conference on 3D Web Technologies* (pp. 89-97).