

The Effect of Viewing Distances on 4K and 8K HDR Video Quality Perception

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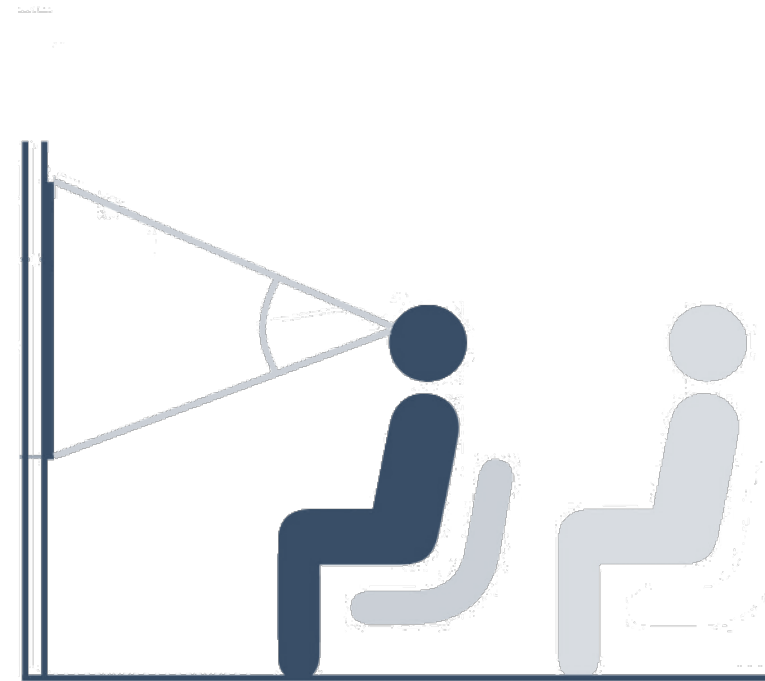
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VQEG Dec. 2023

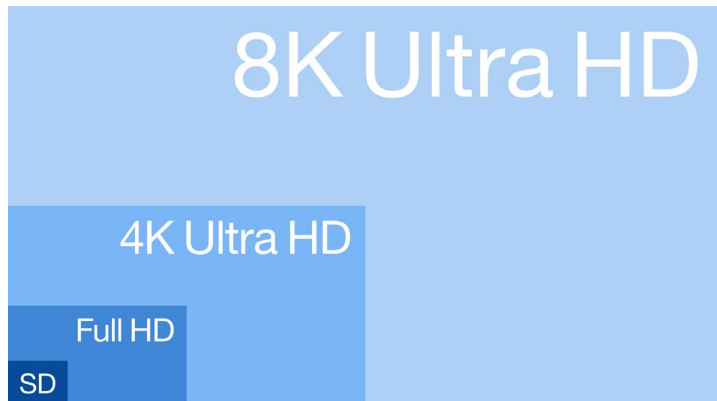


Adapted from <https://visualdisplaysttd.com/resources/tools/specifying/viewing-angles>

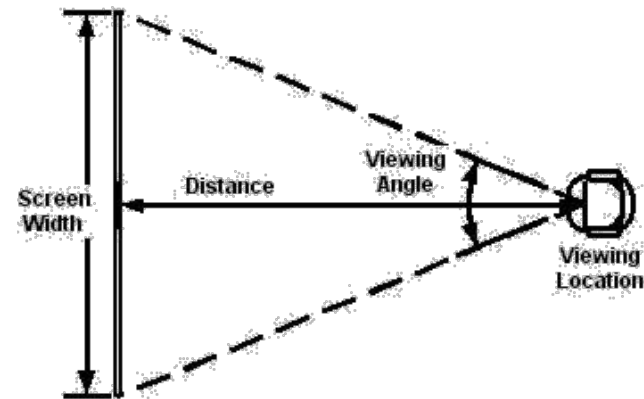
Talk based on [Keller2023b]

Motivation

- 8K (UHD-2) resolution content increasingly available
- Benefits compared to 4K unclear
- Viewing distance (VD): crucial for video quality and higher resolution
- Optimal VD balances resolution, pixel density, screen size, and preferences
- Video quality models use optimal VDs and screen size as factors



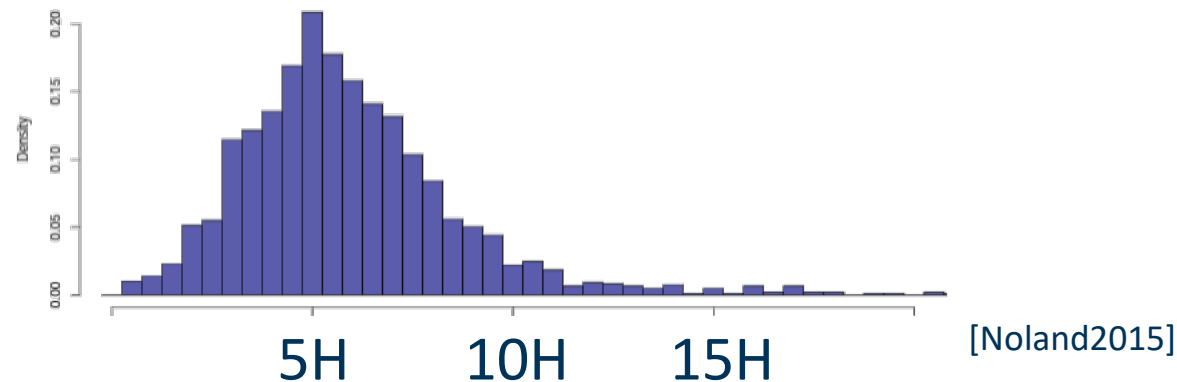
https://en.wikipedia.org/wiki/8K_resolution#/media/File:Resolution_of_SD,_Full_HD,_4K_Ultra_HD_&_8K_Ultra_HD.svg



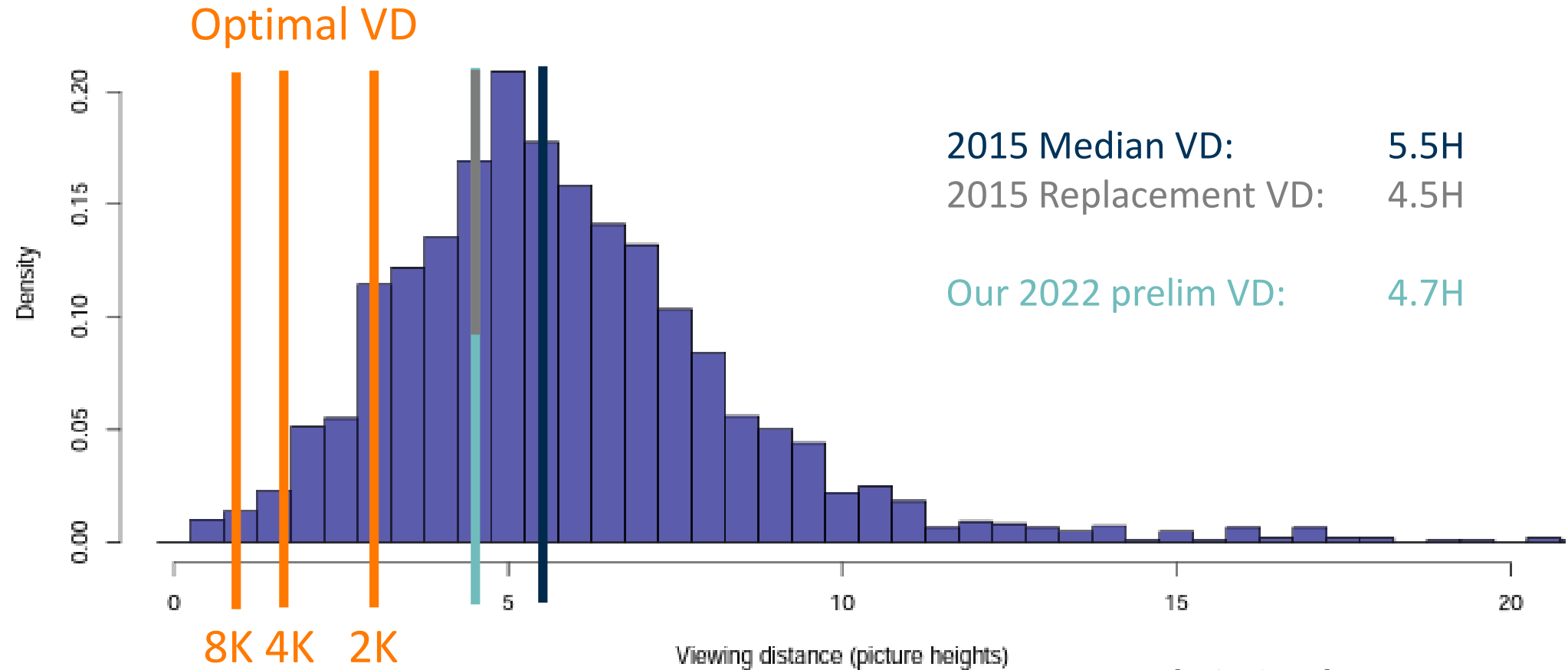
<http://www.hometheaterengineering.com/files/viewing.jpg>

Related Work (1)

- Optimal VD for 4K to be 1.6 H and for 8K to be 0.8 H [BT500]
 - definition based on Snellen's 1 arcmin threshold of 100% (20/20) vision
- VQ models predicting MOS based on VD and display for 8K videos [Sugito2022]
- For suboptimal VDs, differences between resolutions not detected [Kufa2019]
- 82% of UHD TV owners do not sit at the respective optimal distances [Kufa2019]
- Temporal switching methodology suited to distinguish UHD-1 content [Goering2019]



Related Work (2)



[Noland2015]



Research Questions

RQ1: How is UHD video quality being affected by various VDs?

RQ2: Are subjective 8K video quality tests affected by training effects?

RQ3: What is the preferred VD for 8K viewing situations?

RQ4: Is it worth watching 8K content in a living room scenario?



Experiment: Dataset

- 9 8K HDR SRCs
- 5 4K HDR SRCs
- Bit depth: 10 bit, subsampling: 4:2:0
- Transfer function: BT.2020
- Frame rate: 30 or 60 fps
- Codec: H.265, CRF 12
- Length: 2x 8 s
- Varying spatial complexity (SI)

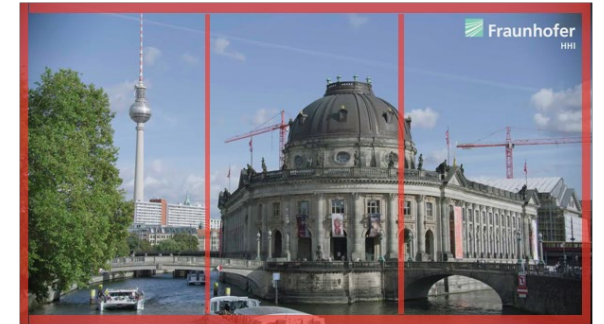


Experiment: Setup

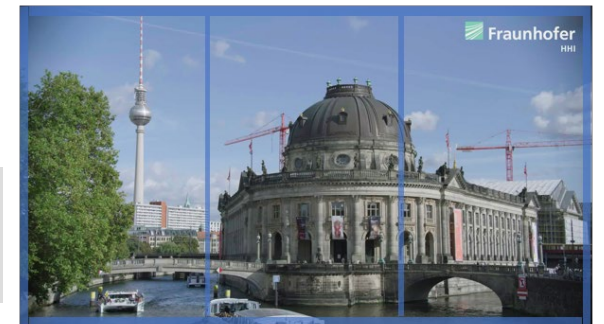
- Test room acc. to ITU Recs. BT.500 and P.910
- 86" LG 8K 86QNED919PA TV used (H = 1.07m)
- 7 VDs: 0.5 H, 0.8 H, 1.2 H, 1.6 H, 2.0 H, 2.6 H, 3.0 H
- Random order of VDs
- Paired temporal switching comparison and quality rating
- Quality rating:

Which version of this sequence did you perceive as better? User ID: 35

Red is better	Red is slightly better	None is better	Blue is slightly better	Blue is better



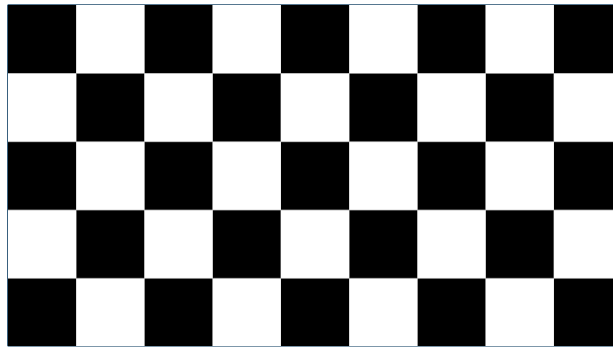
↕ 2s



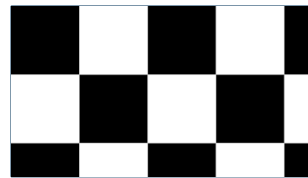
- Before and after study: subjects to select preferred VD for watching a movie

Experiment: Comparisons (1)

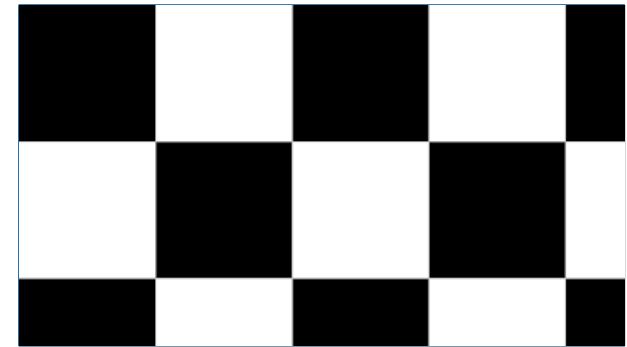
- 8K vs. 4K
 - 4K created by downscaling using a Lanczos based algorithm
 - For playout reasons, re-upscaled to 8K using a nearest neighbor algorithm



Original 8K



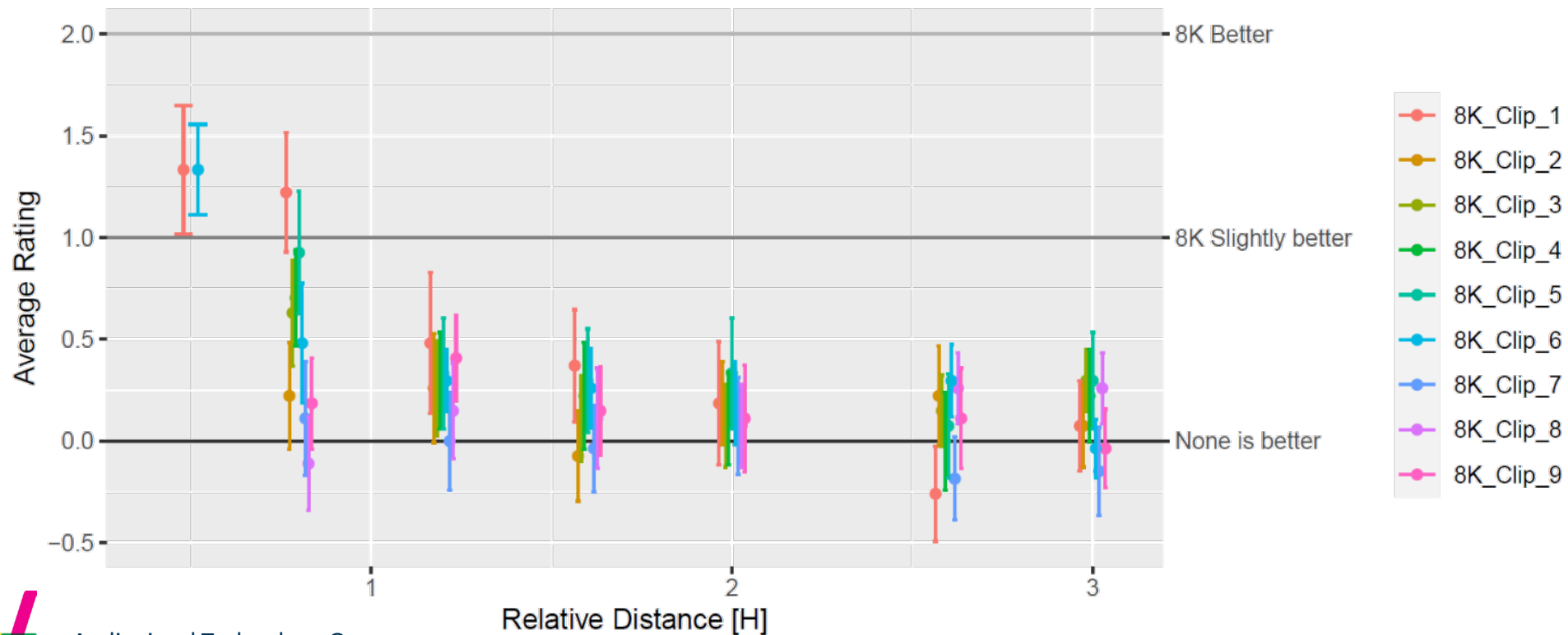
Downscaled 4K



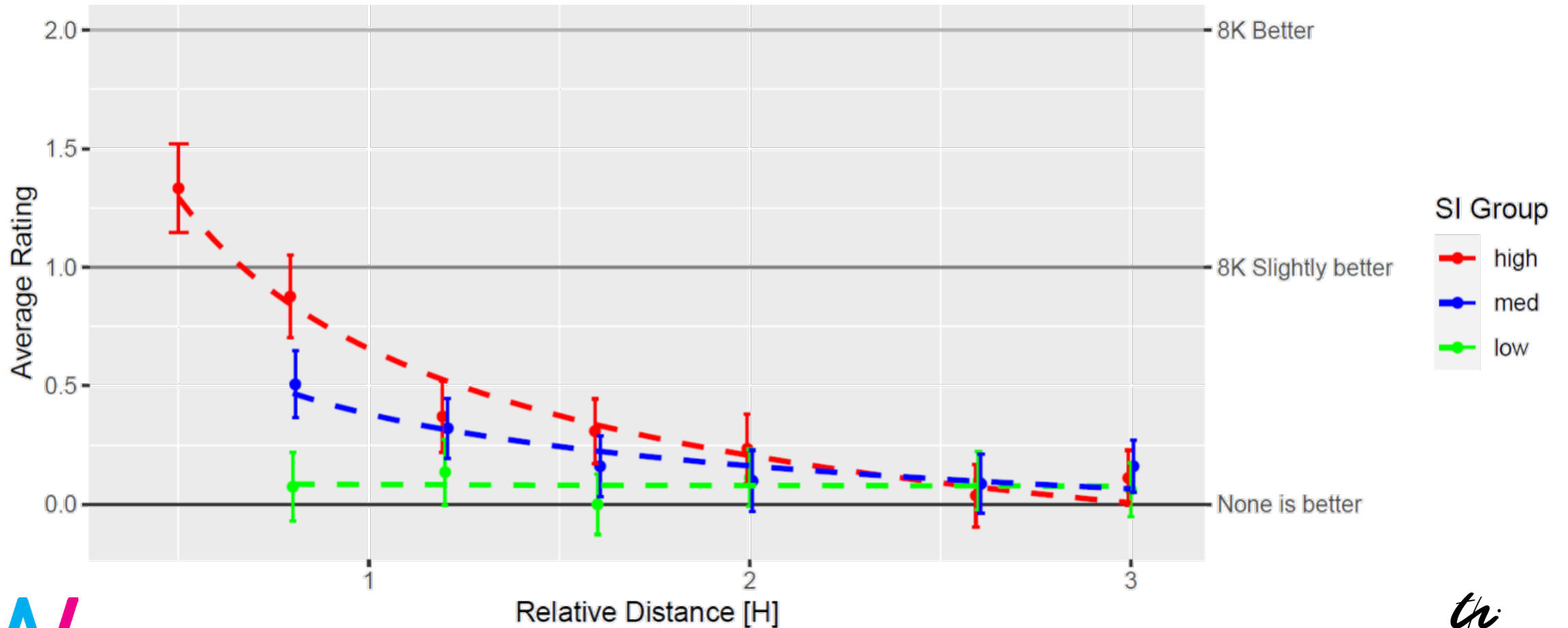
Re-upscaled 4K

Results: 8K vs. 4K (1)

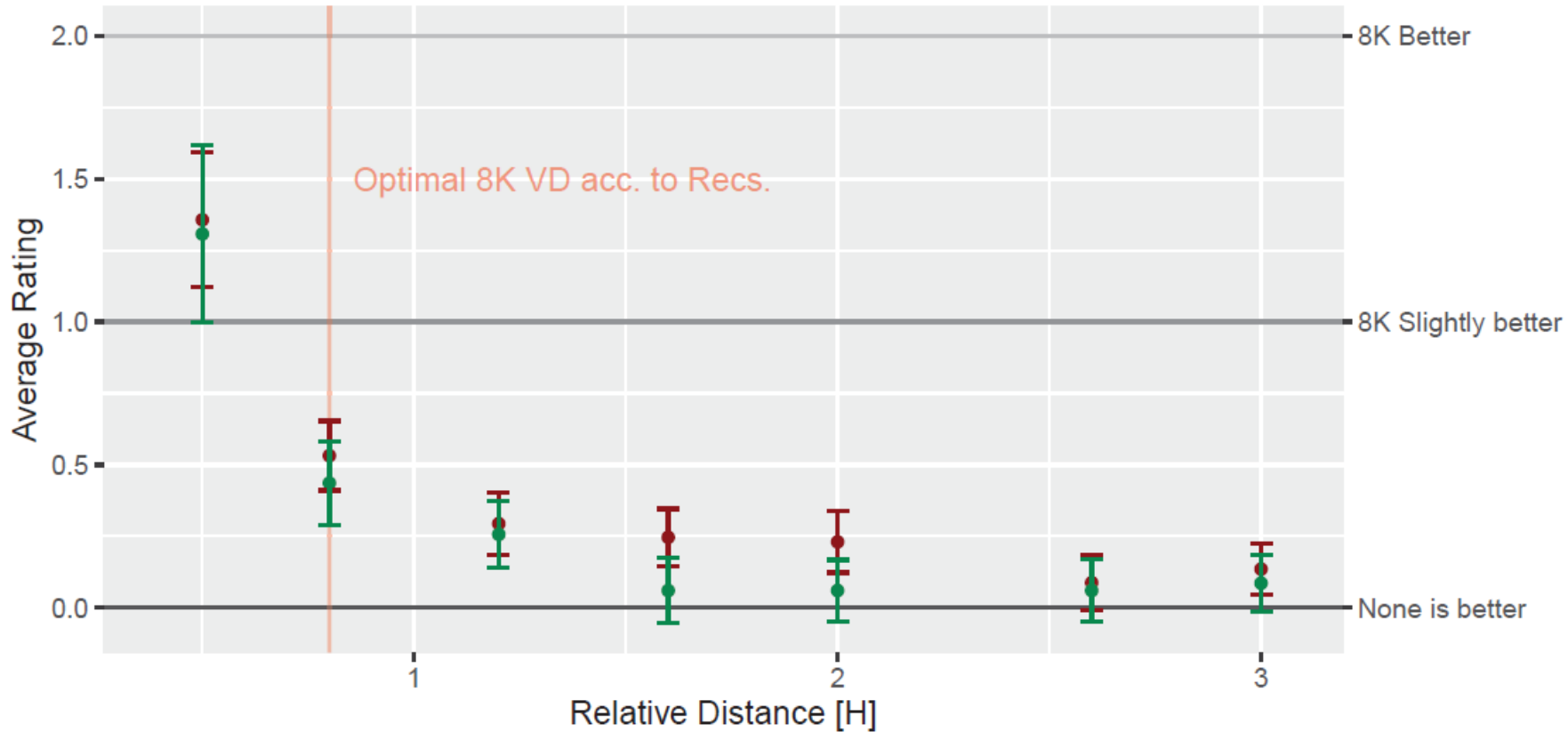
- 27 valid subjects (median age: 26)
- Re-calculated ratings so that positive values prefer 8K / enhanced 4K



Results: 8K vs. 4K (2)



Results: Acuity ratings

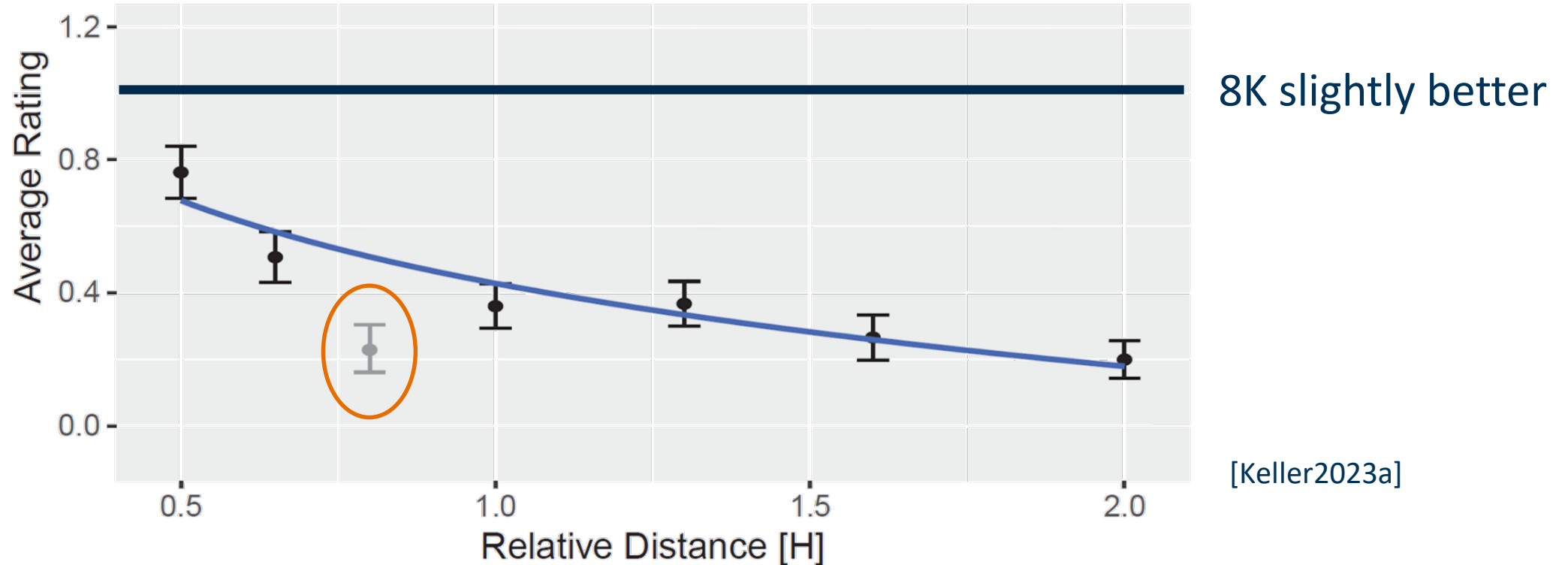


Threshold:
decVA = 1.57

Acuity Group

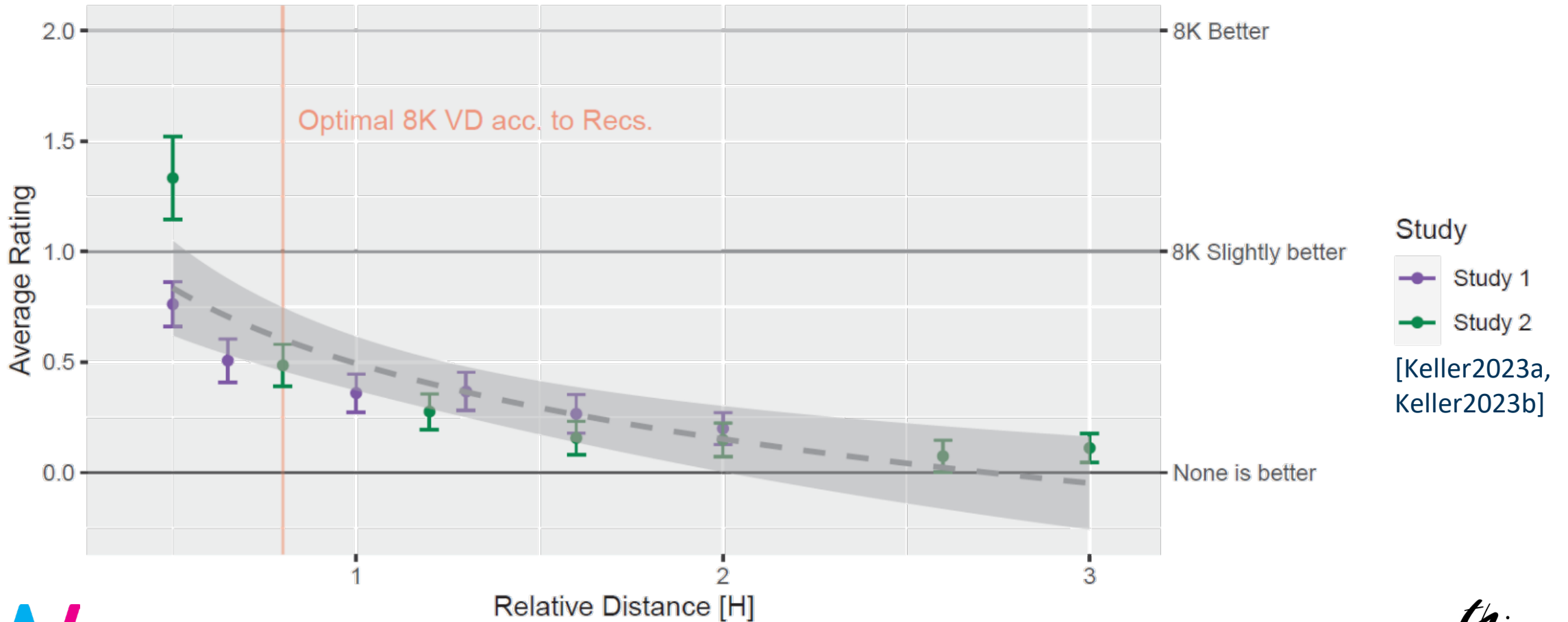
- High
- Low

Earlier study: Result



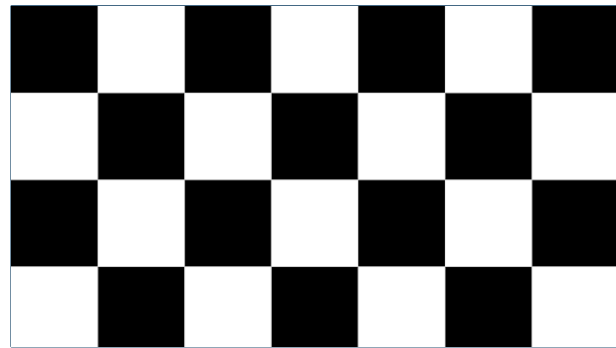
Drop in ratings observed at the first tested distance (0.8H), possibly due to subjects' unfamiliarity with the content

Results: 8K vs. 4K (3)

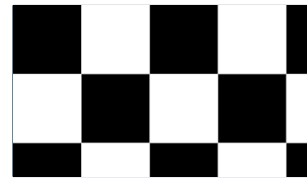


Experiment: Comparisons (2)

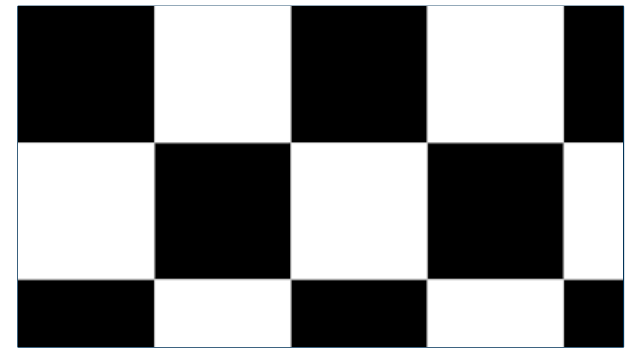
- 4K+ vs. 4K (both upscaled to 8K)
 - Lanczos based algorithm (enhanced 4K+)
 - Nearest neighbor algorithm (native 4K)



enhanced 4K+

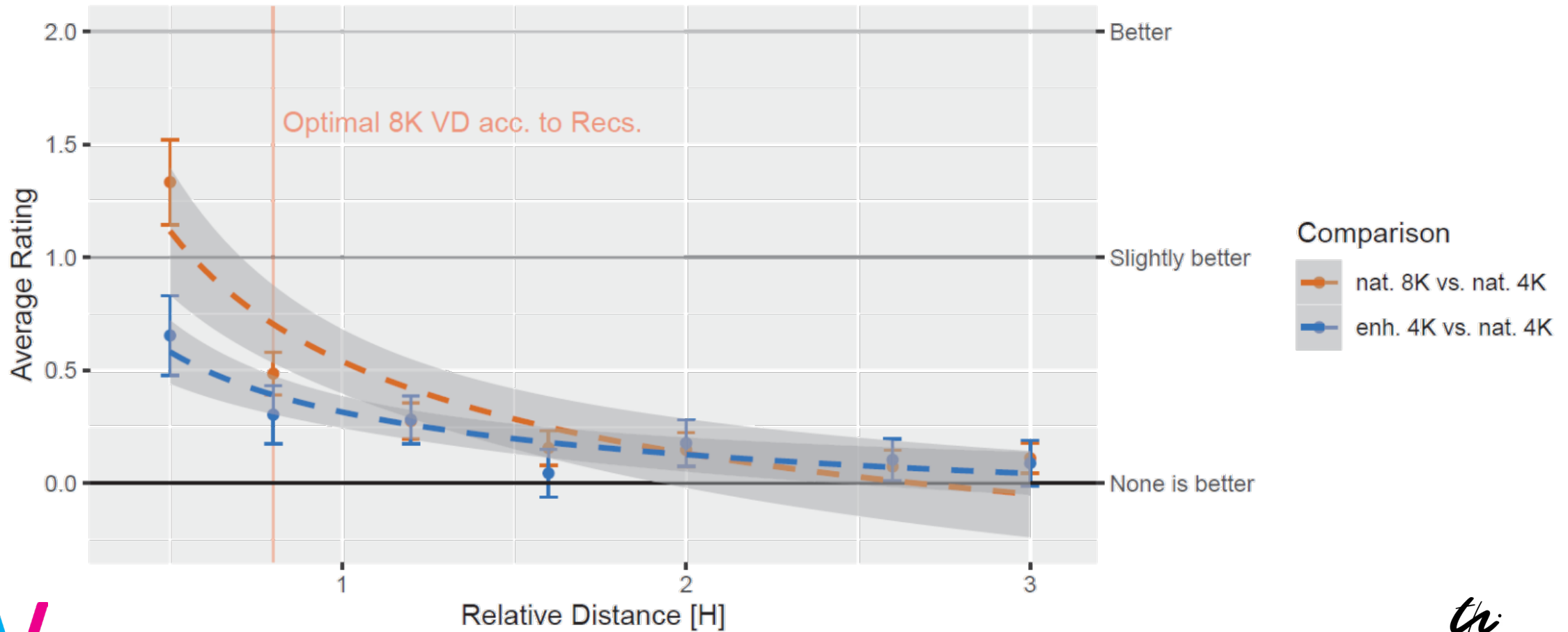


original 4K



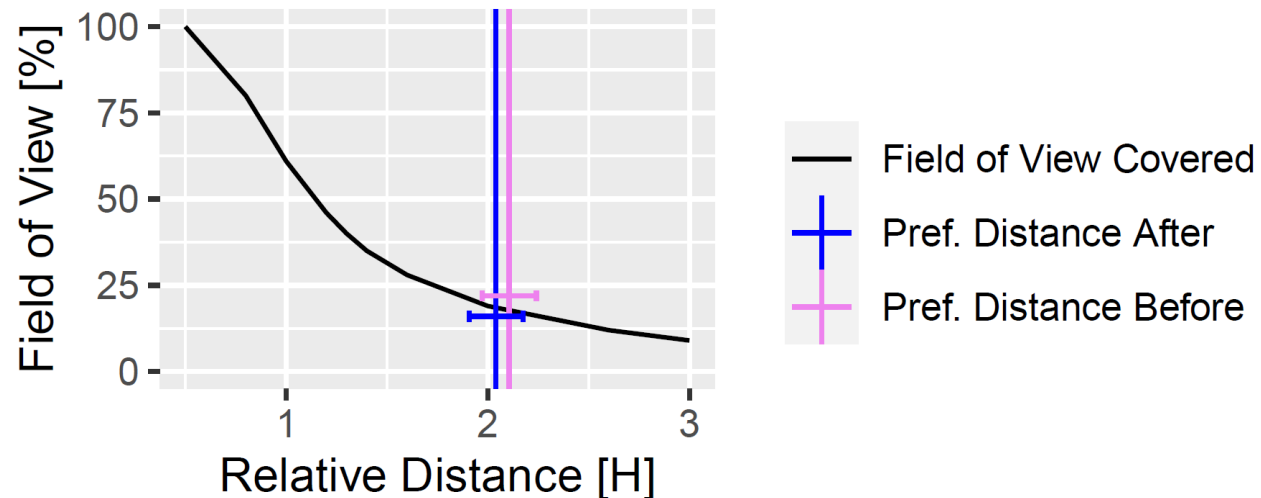
native 4K

Results: 8K vs. 4K and 4K+ vs 4K



Results: Preferred Viewing Distance

- Average viewing distance in living room scenarios $> 4.5 H$ [Noland2015]
- 8K improving video quality for distances up to $2 H$
- Preferred viewing distance of $2.1 H$, vertical viewing angle of 45°
- Resulting usage of the Field of View of 18%

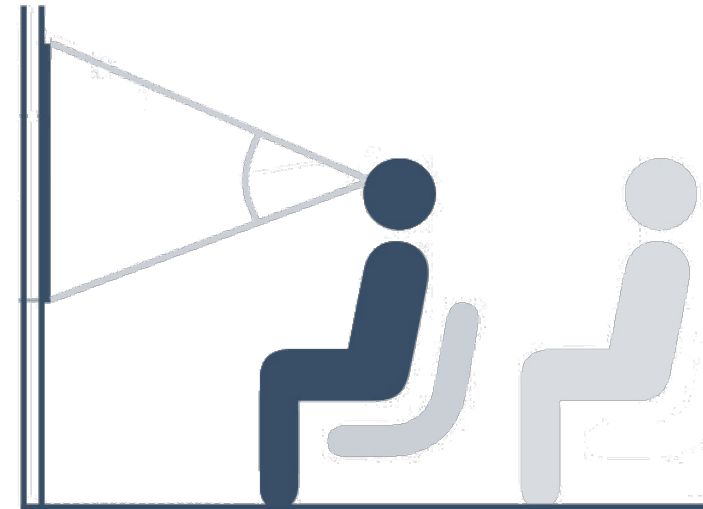


Conclusion and Future Work

- RQ1: Strong influence of VDs on UHD video quality
 - 8K only profits over 4K for close VDs up to 2 H and complex videos
- RQ2: When repeating contents, training effects visible: Realistic living room scenarios decrease usefulness of 8K even further
- RQ3/4: Preferred VD for 8K video
 - exceeds the range where benefits of 8K resolution visible, however,
 - is closer than most living room VDs.
- 4K Lanczos upscaling useful at close distances
- Towards studying 8K video quality on **encoded** or **non-repetitive** contents
- Towards JNDs, an acceptability distance and inclusion into models



Thank you for your interest.



For exchange or information,
please contact dominik.keller@tu-ilmenau.de

D. Keller et al., "Influence of Viewing Distances on 8K HDR Video Quality Perception,"
2023 15th International Conference on Quality of Multimedia Experience (QoMEX), Ghent, Belgium, 2023

D. Keller et al., "The Effect of Viewing Distances on 4K and 8K HDR Video Quality Perception,"
2023 IEEE International Symposium on Multimedia (ISM), Laguna Hills, CA, USA, 2023



Sources

- [BT500] International Telecommunication Union. *Recommendation ITU-R BT.500-14: Methodology for the subjective assessment of the quality of television pictures*. Recommendation BT.500-14. ITU-R, 2014.
- [Noland2015] K. Noland et al. “A survey of UK television viewing conditions”. In: *BBC Research & Development White Paper 287 (2015)*, pp. 1–58.
- [Keller2023a] D. Keller et al. “Influence of Viewing Distances on 8K HDR Video Quality Perception”. In: 2023 15th QoMEX. IEEE. 2023, pp. 209–212.
- [Keller2023b] D. Keller et al. “The Effect of Viewing Distances on 4K and 8K HDR Video Quality Perception’. In: 2023 IEEE International Symposium on Multimedia (ISM), Laguna Hills, CA, USA, 2023 – **not yet available**
- [Goering2019] S. Göring et al. “Analyze and predict the perceptibility of UHD video contents”. In: *Electronic Imaging 2019.12 (2019)*, pp. 215–1.
- [Sugito2022] Y. Sugito et al. “Modeling Perceived Quality on 8K VVC Video Under Various Screen Sizes and Viewing Distances”. In: *IEEE Access 10 (2022)*, pp. 97237–97247.
- [Kufa2019] J. Kufa et al. “Visual Quality Assessment Considering Ultra HD, Full HD Resolution and Viewing Distance”. In: *2019 29th International Conference Radioelektronika (RADIOELEKTRONIKA)*. 2019, pp. 1–4.

