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Tested Perceptual Difference Between 4K & 8K

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MOTIVATION

What's the impact of higher resolution displays with larger screen sizes on the user experience?

Assess the perceptibility of 4K vs 8K resolution on 8K consumer displays at typical viewing distances for various types of content.

PARTNERS



PIXAR
ANIMATION STUDIOS



prime video



CONTENT SELECTION

7 clips (10 seconds each) of *native* 8K HDR content

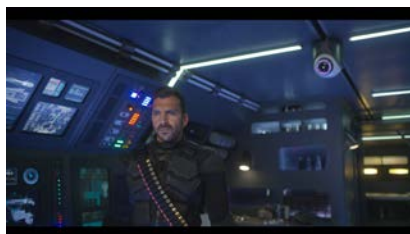
4K HDR version derived from native 8K HDR version

Dunkirk



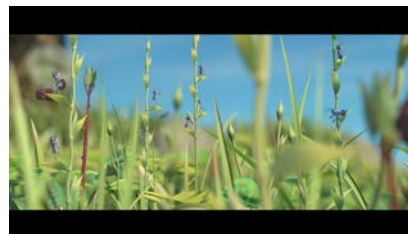
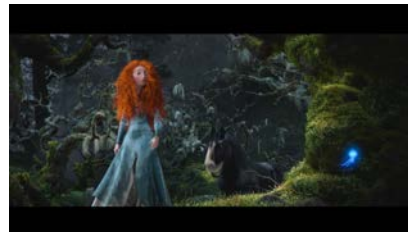
8K Film Scans

Tick



8K RED Digital

Brave
A Bug's Life










8K Animation

Nature
(Stacey Spears)



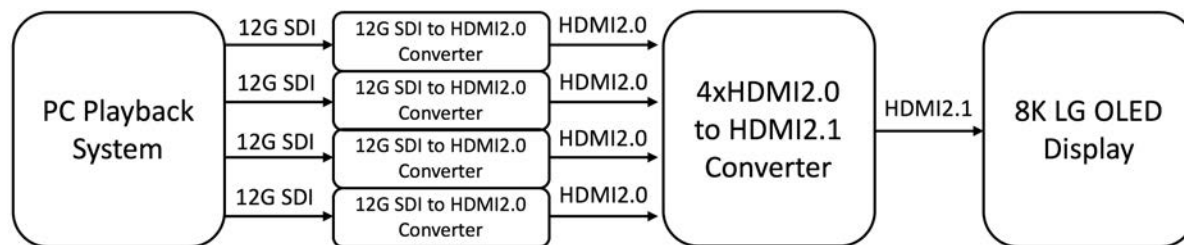
8K RED Digital

HDR CONTENT STATISTICS

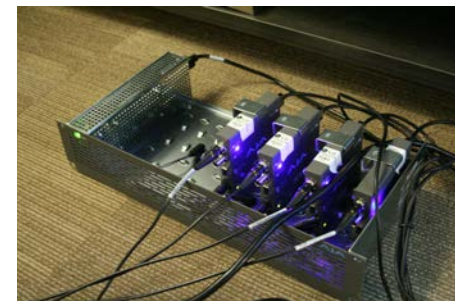
CLIP DESCRIPTION		CLIP NUMBER	MaxFALL	MaxCLL
	DUNKIRK CLOSE	1	160	490
	DUNKIRK WIDE	2	226	445
	BRAVE	3	1.5	103
	A BUG'S LIFE	4	94	375
	TICK 'CAVE'	5	4.2	1,016
	TICK 'SPACESHIP'	6	18	1,000
	NATURE	7	372	3,000

TEST EQUIPMENT

- LG 88" 8K OLED display
- Uncompressed 8K playback system
 - PC with Intel 18-core i9 CPU & SSD RAID & Nvidia GeForce 1080Ti GPU
 - BlackMagic 8K Pro video interface (Quad SDI)
 - 4x AJA SDI to HDMI & Astrodesign HDMI 2.0 to HDMI 2.1 converters

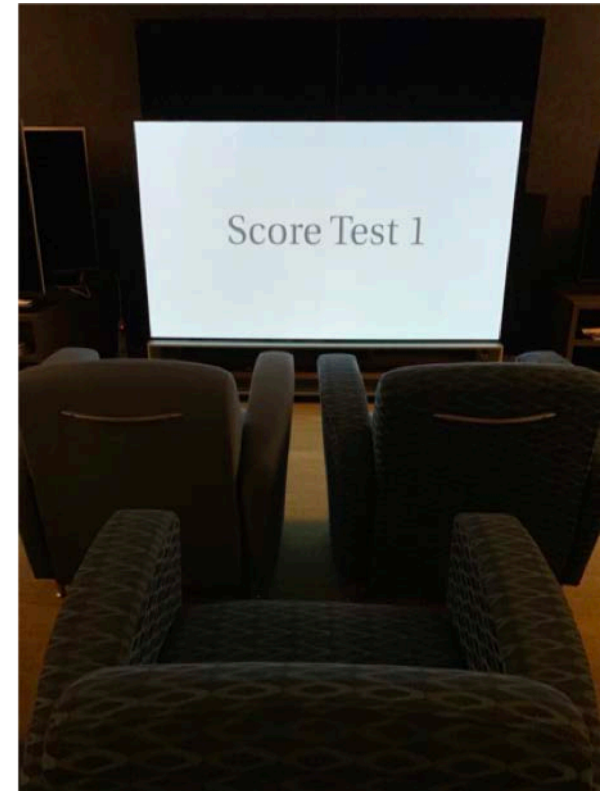
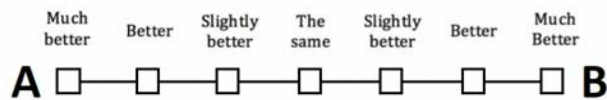


- Playback used 10bit BT.2100 PQ 7680x4320/24p format DPX files
 - Needs at least 3,000 MB/sec sustained file read rate



TEST PROCEDURE

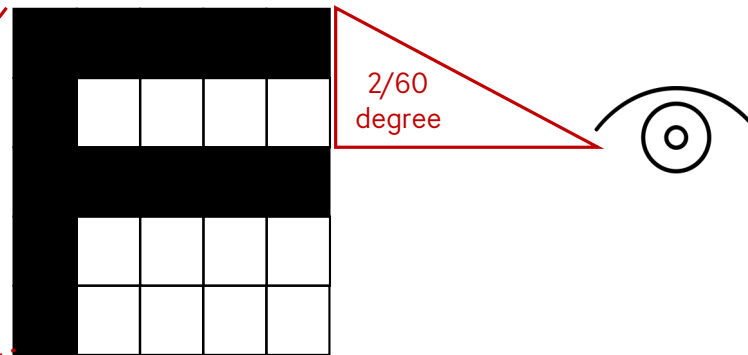
- In total 139 individuals participated
- 5 participants per session
 - 2 seats in front row (5 feet from screen)
 - 3 seats in back row (9 feet from screen)
 - 7 feet from screen = 2 screen heights
- Procedure performed as a “Double Blind” test
 - Each sequence consisting of two versions of the same clip, presented twice (A / B / A / B / Scoring)
 - Each sequence presented 3 times with different order (8K vs 4K / 4K vs 8K / 4K vs 4K)



VISION SCIENCE REVIEW – 20/20 VISION

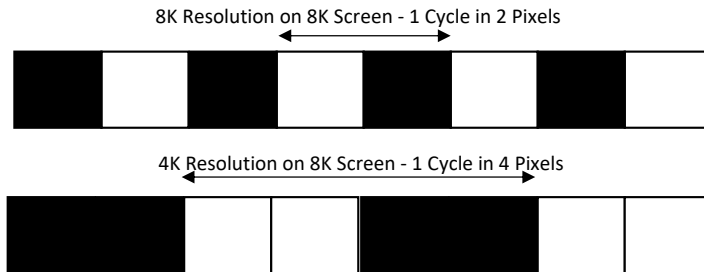


Letter “F” on 20/20 line has maximum spatial frequency $60/2 = 30$ cycles per degree



20/20 vision means a viewer can clearly see 30 cycles per degree

VISION SCIENCE REVIEW – PIXEL DENSITY



- Geometry of viewing test and vision performance determines whether details above 4K resolution are visible.
- Front row seats were 5-feet from screen
 - 4K Resolution Visual Frequency = 25 cycles/degree
- Back row seats were 9-feet from screen
 - 4K Resolution Visual Frequency = 47.5 cycles/degree

Vision Performance	Visual Frequency Threshold (cycles/degree)	Visual Frequency Threshold / 4k Resolution Visual Frequency	
		Front Row	Back Row
20/20	30	1.2	0.6
20/15	45	1.8	0.9
20/10	60	2.4	1.3

Compare Vision Threshold to 4K Resolution Visual Frequency to determine if visual frequencies beyond 4K resolution are visible.

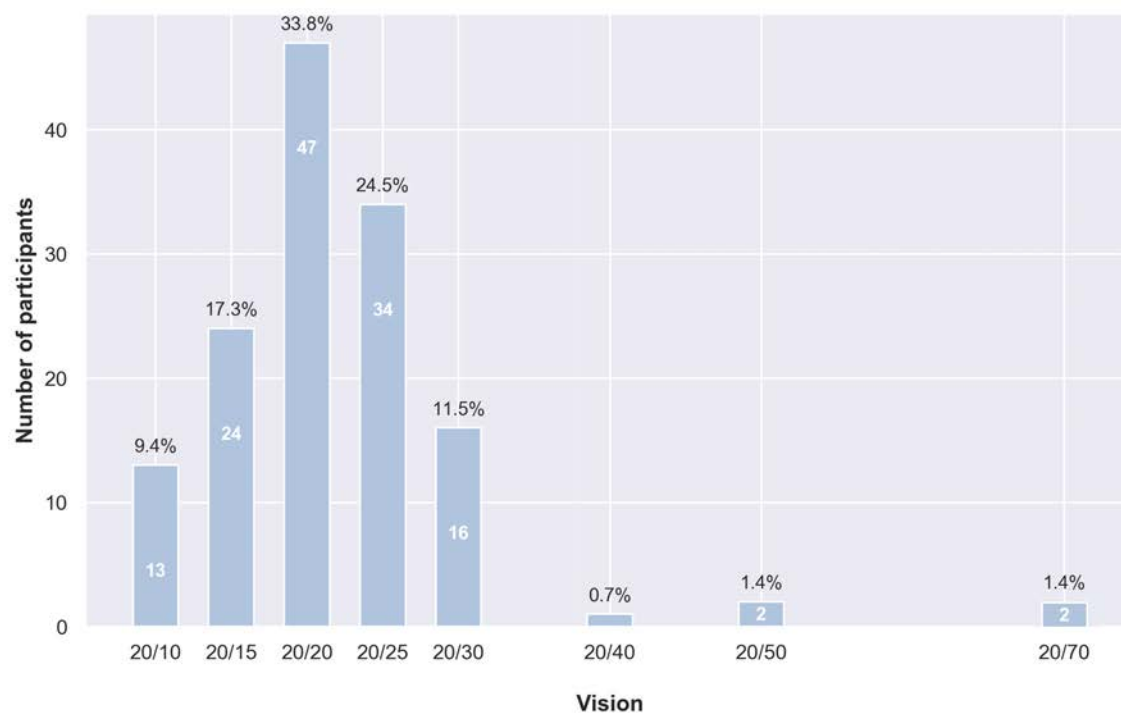
In table above, 1.0 means only 4K resolution is visible; 2.0 means 8K resolution is visible.

Viewers with 20/10 vision in the front row can see **8K resolution**; in the back row can see **4K resolution**.

Viewers with 20/20 or better vision in the front row can see **higher than 4K resolution**.

VISUAL ACUITY OF PARTICIPANTS

Histogram of vision amongst participants



27% with **better** than 20/20 vision

34% with **20/20** vision

39% with **worse** than 20/20 vision

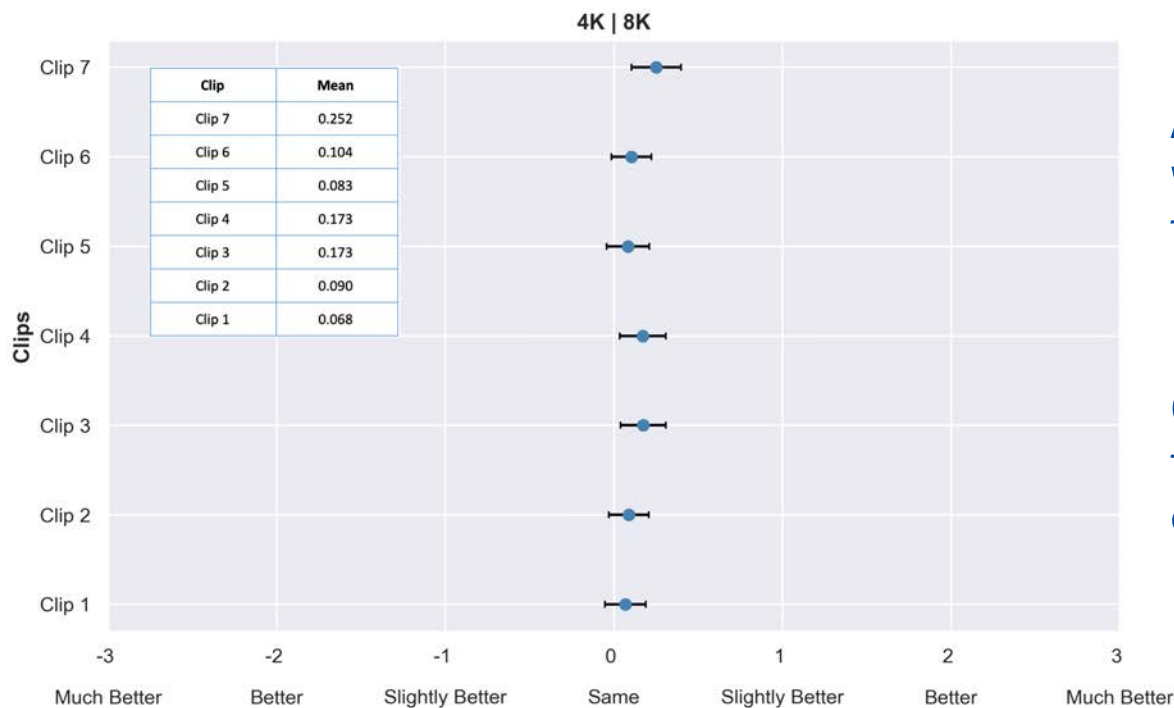
A close-up, action-oriented shot of Wonder Woman. She is shown from the chest up, wearing her iconic golden armor and tiara. Her right arm is extended forward, with her fist clenched, and a bright, glowing light emanates from her gauntlet. Her left hand is raised near her face, with fingers slightly curled. She has a determined, intense expression on her face, looking directly at the viewer. Her long, dark hair is blowing in the wind. The background is a soft, out-of-focus mix of warm orange and yellow tones on the left, transitioning to a cooler blue on the right, suggesting a sky or a battlefield environment with some floating particles.

TEST RESULTS

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AVERAGE OF ALL RESULTS

95% confidence interval of the expected score value



Across all participants, on average, 8K was rated marginally “Slightly Better” than 4K

Confidence intervals overlap, therefore no conclusion about differences between clips

8K DETAILS MATTER ... with better vision



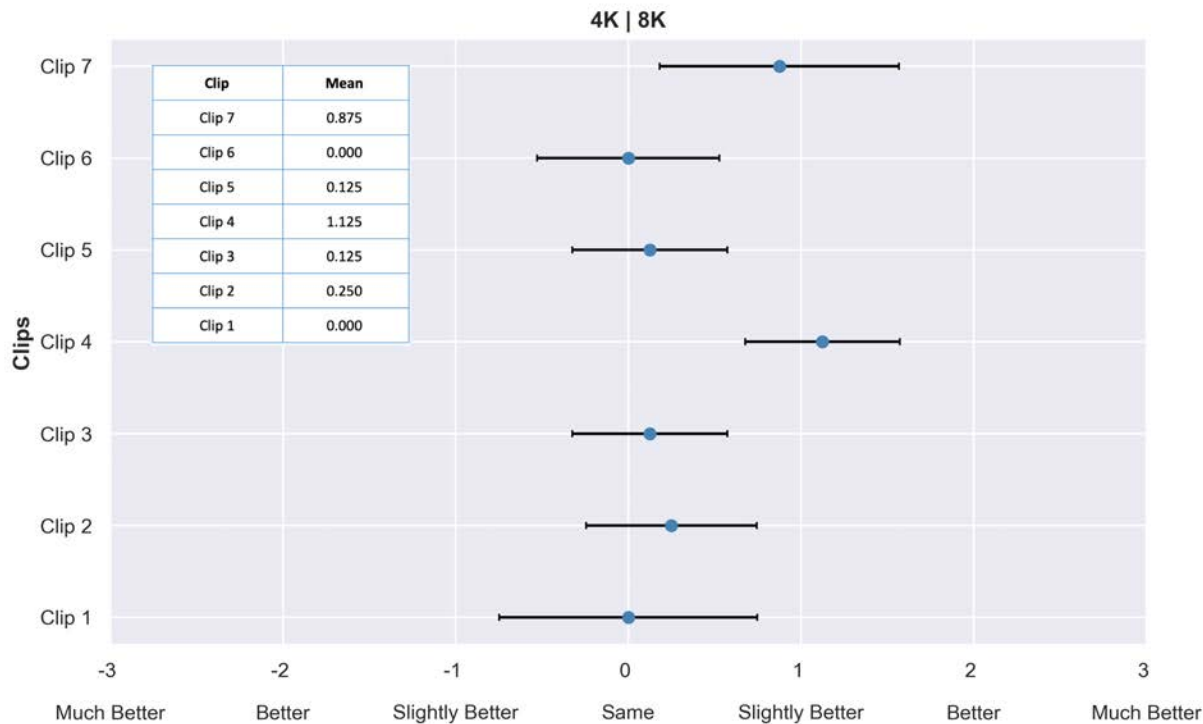
Average across **all** participants



Average across participants with
20/20 or better vision

8K DETAILS MATTER ... with better vision

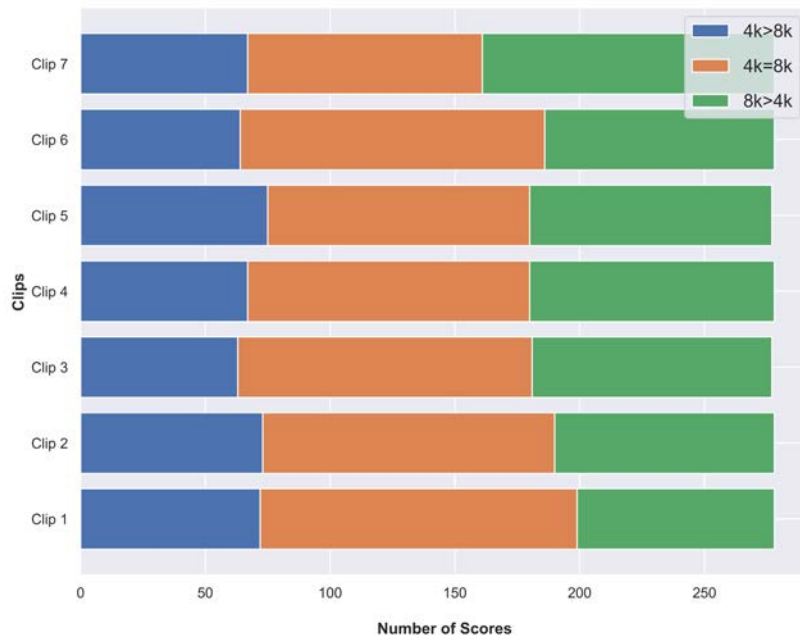
95% confidence interval of the expected score value for 20|10 front row



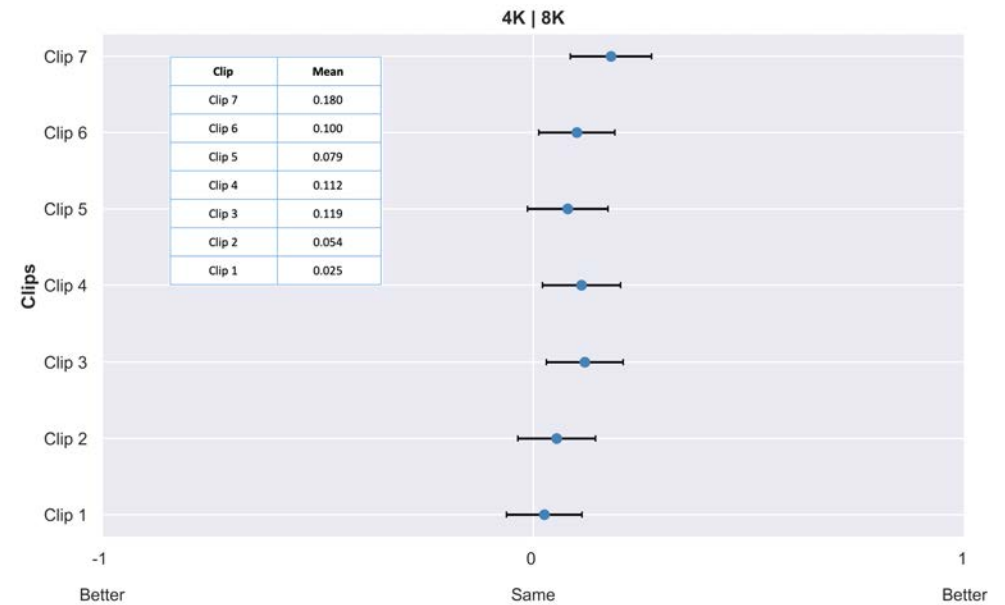
For Clip 4 and Clip 7, viewers with excellent **20/10 vision** sitting close to the screen rated 8K versions “Slightly Better” than 4K version

EQUALLY WEIGHTED SCORES

Quantized Score Distribution



95% confidence interval for equally-weighted expected score value



Shows Clip 7 had different distribution of scores

CONCLUSIONS

- Test results show that increasing resolution from 4K to 8K under typical viewing conditions did not result in a significantly improved visual difference.
- Perceptual difference is highly content dependent.
- Perceptual difference is tied to vision science.
 - Viewers with 20/10 vision in the front row confidently rated two of 8K clips as “Slightly Better”
 - 27% of participants had better than 20/20 vision
 - ITU may want to consider revising its recommendations about viewing distance to include viewers with 20/10 or 20/15 vision

THANK YOU

