Subtitles and HDR

SubTech I

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Introduction

- We present some of the work the BBC did to determine the effect high dynamic range (HDR) video will have on subtitles.
- We wanted to verify the transfer function proposed in TTML2 for compositing subtitles over HLG HDR video.
- We wanted to determine if the greater dynamic range of HDR video created any new issues we might need to mitigate for.

Colour in TTML Subtitles

```
TTML Colour Name      8-bit RGBA (Hex)
| "black"          // #000000ff
| "silver"         // #c0c0c0ff
| "gray"           // #808080ff
| "white"          // #ffffffff
| "maroon"         // #800000ff
| "red"            // #ff0000ff
| "purple"         // #800080ff
| "fuchsia"        // #ff00ffff
| "magenta"        // #ff00ffff (= fuchsia)
| "green"          // #008000ff
| "lime"           // #00ff00ff
| "olive"          // #808000ff
| "yellow"         // #ffff00ff
| "navy"           // #000080ff
| "blue"           // #0000ffff
| "teal"           // #008080ff
| "aqua"           // #00ffffff
| "cyan"           // #00ffffff (= aqua)
```

- TTML allows 16.7M colours, each with 256 levels of opacity
- 18 Named TTML Colours (four highlighted are used by BBC)
- sRGB Colour Space
- Display-referred with peak white at 80 cd/m^2 (usually ignored in SDR)

TTML2 HDR compositing

- Annex Q.2 defines a possible mapping to composite sRGB pixels onto Hybrid Log-Gamma (HLG) pixels.
- Peak white in sRGB is mapped to 75% of the narrow range signal defined in ITU-R BT.2100-1.
- No metadata is needed for the HLG mapping

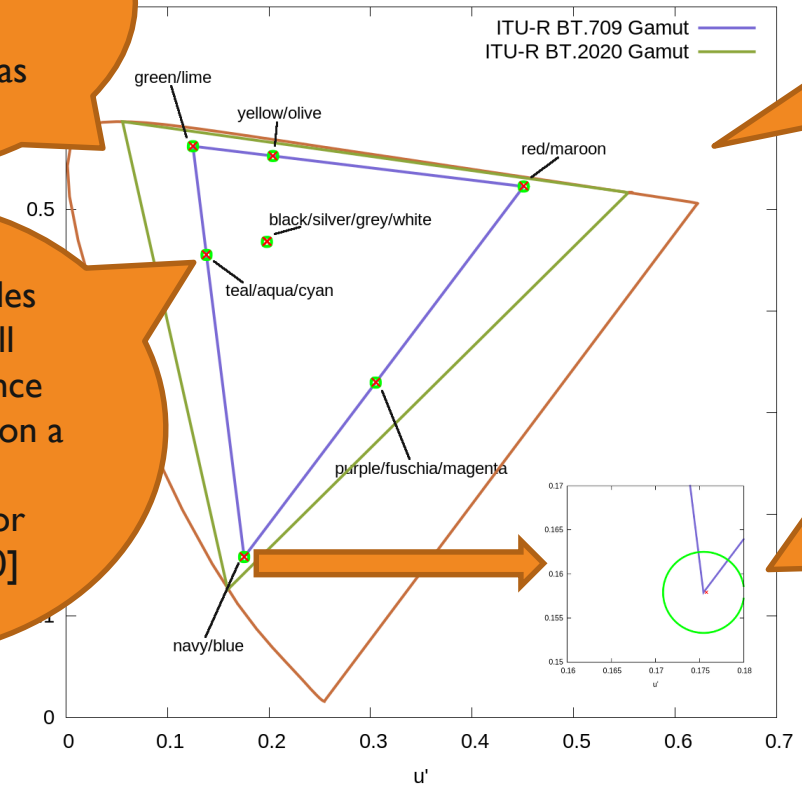
Transform accuracy

We converted the named TTML colours using the algorithm defined in TTML2 Annex Q.2 (shown as red crosses)

All named colours are within their target circles.

Green target circles represent a small noticeable difference for non-skin-tones on a Grade 1 HDR reference monitor [EBU TECH3320]

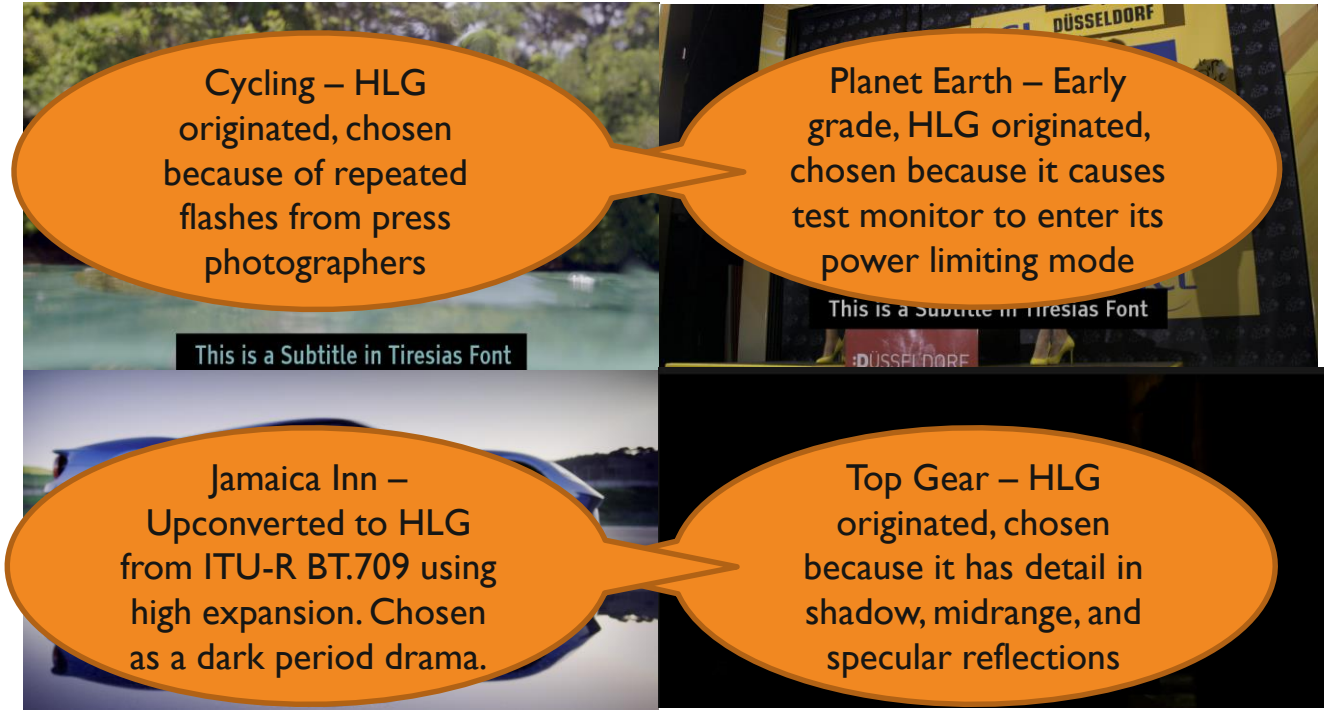
Navy and blue colours are slightly outside the ITU-R BT.709 gamut but within the ITU-R BT.2020 gamut.



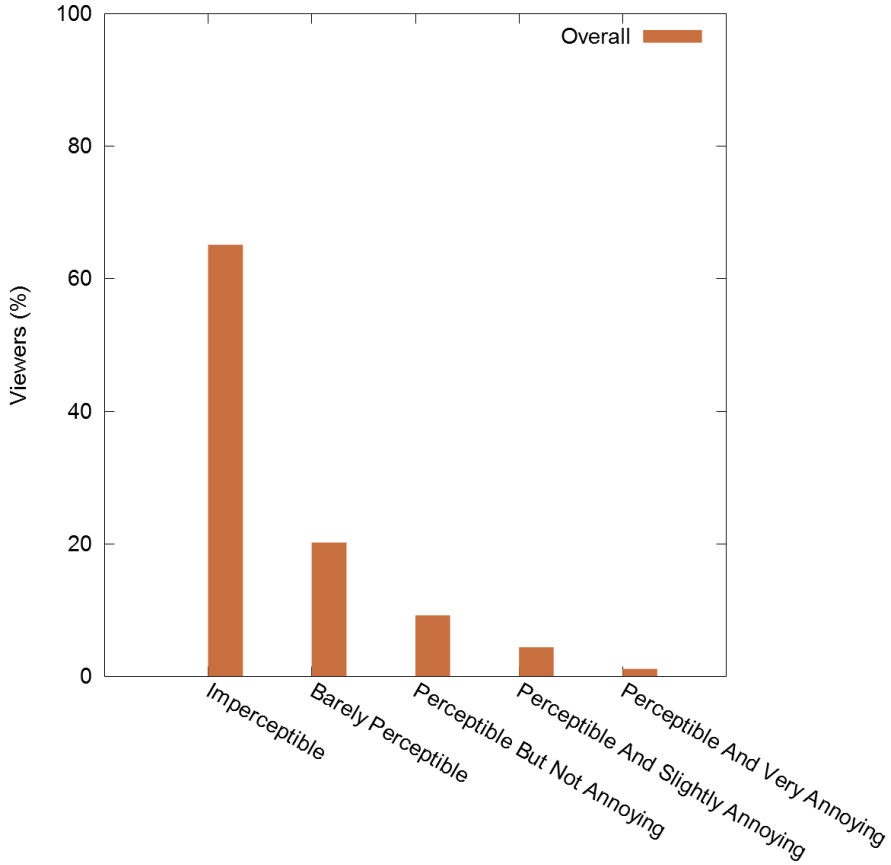
Subjective Testing

- We undertook subjective testing with 19 test candidates, using a Sony BVM-X300 monitor in HLG mode.
- Viewers were seated at three times picture height (48”/122cm).
- Room arranged in accordance with the reference viewing conditions listed in ITU-R BT.2100 with LED lighting illuminating the surround
- The viewers were asked to grade each sequence for consistency of brightness of the subtitles through the sequence and overall brightness.

Video Test sequences

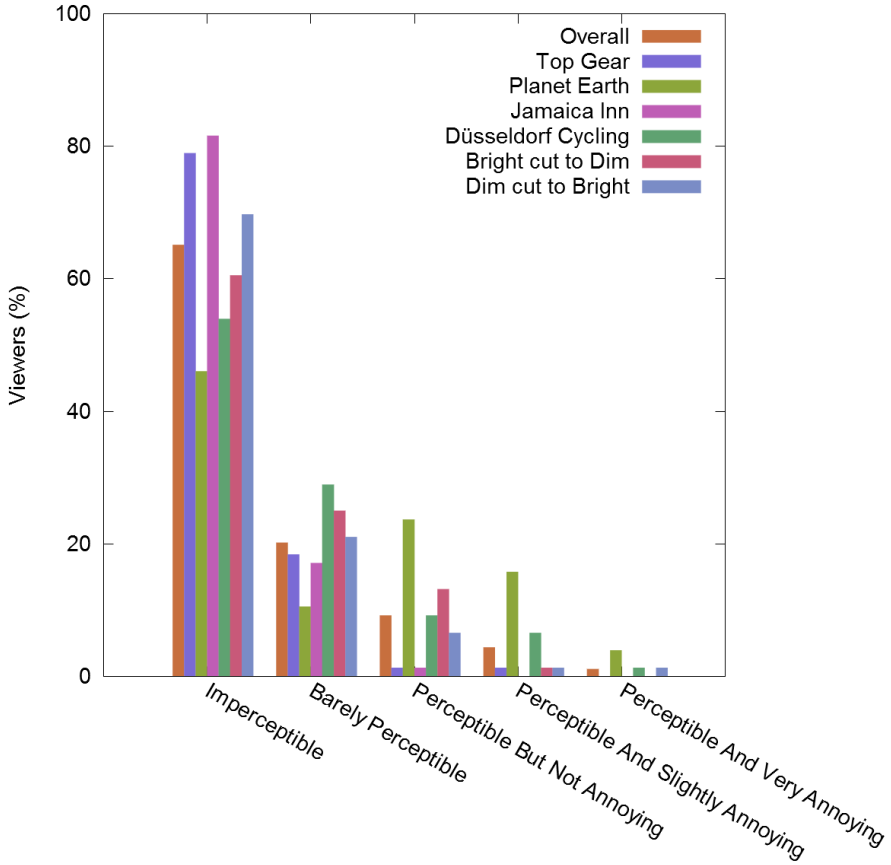


Temporal consistency



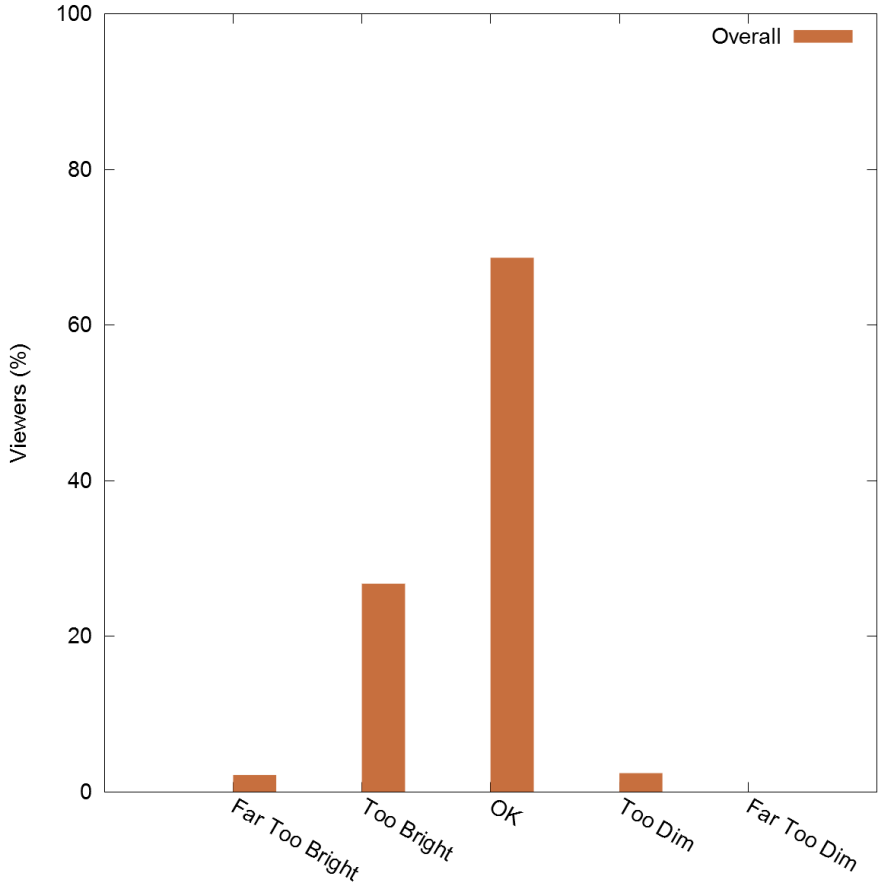
- Viewers were asked to judge the test sequences based on perceived changes of subtitle brightness over the duration of the clip.
- Tests to determine if viewers perceived the subtitles to be varying in brightness due to varying brightness of video content.
- The results show generally the viewers didn't find any perceived temporal inconsistency annoying.
- However results are video clip dependent

Temporal consistency



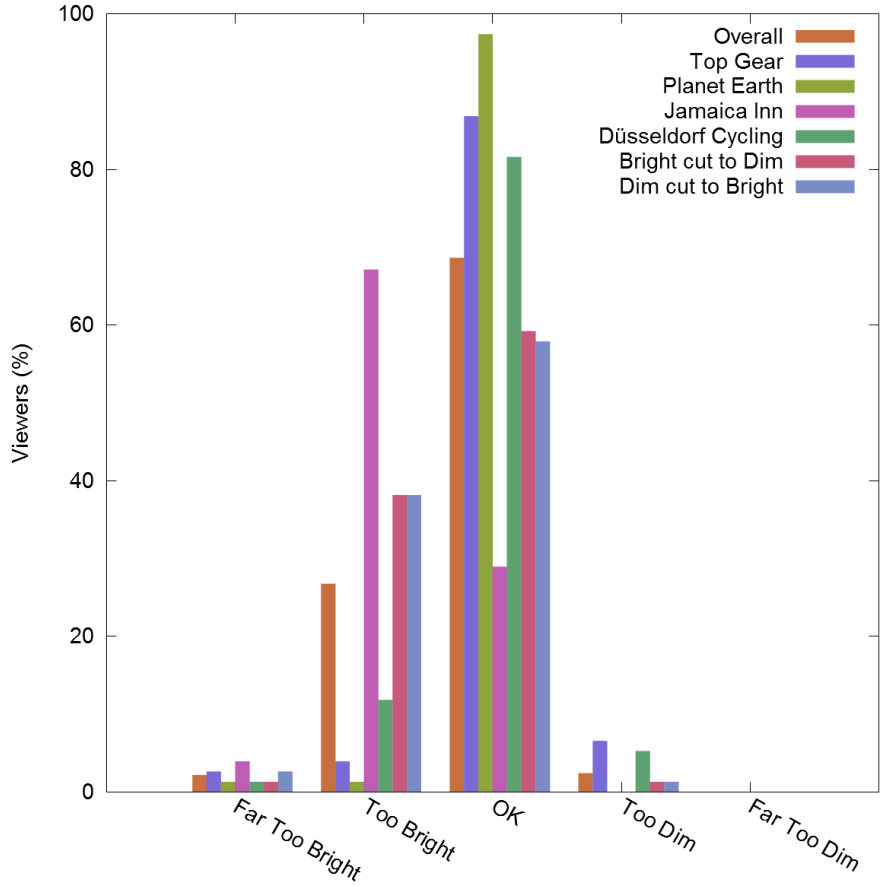
- The Planet Earth clip had the highest annoyance factor. It was a early grade not to current production guidelines that caused the display to repeatedly initiate a power saving mode. Later grades to production guidelines do not have this effect.
- The repeated photography flashes in the cycling clip was also noticeable.
- Switching between the dark Jamaica Inn and the bright Top Gear clip was also noticeable.

Overall Subtitle brightness



- Viewers were also asked to judge the test sequences based on perceived overall subtitle brightness for the duration of the clip.
- Results are video clip dependent.
- The overall results biased by Jamaica Inn results.

Overall Subtitle brightness



- Generally the subtitle brightness is acceptable.
- For extremely dark (Jamaica Inn clip) content the brightness of subtitles appeared to be too bright.
- Subtitles also appeared a little too bright when the video cut between light and dark content.

Conclusions

- Adherence to HDR brightness production (video) guidelines is important.
- Content producers should be aware that when producing content with rapid, repeated changes in brightness level, some users will find that the brightness of subtitles perceptually change.
- Not specific to HDR: Try to avoid using subtitles across scene cuts especially if there is a significant brightness change.
- Not specific to HDR: Consider using a less bright colour for subtitles over dim content (e.g. replace White with Grey)

Thank you

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