PERCEPTUAL PREFERENCE OF S3D OVER 2D FOR HDTV IN DEPENDENCE OF VIDEO QUALITY AND DEPTH

Pierre Lebreton, Alexander Raake, Marcus Barkowsky, Patrick Le Callet

VQEG, 07/08-12/2013

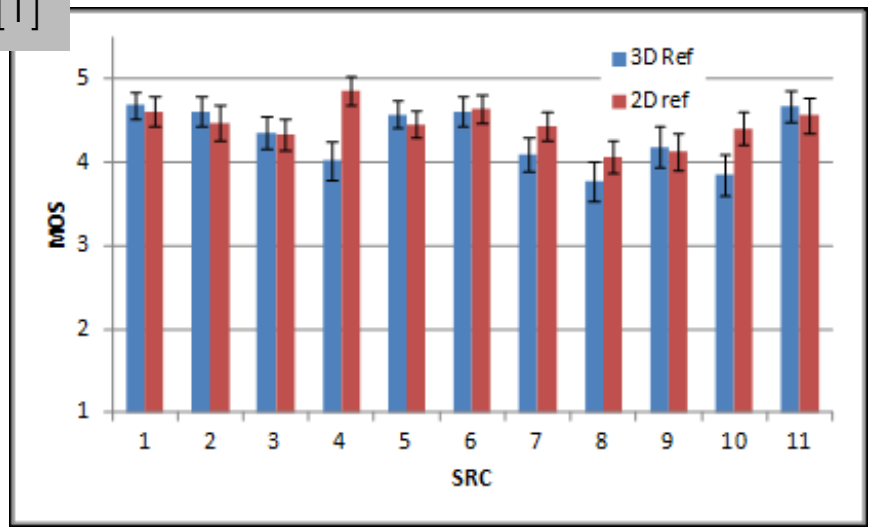
Outline

- **Motivation**
- Experiment
- Results
- Conclusion

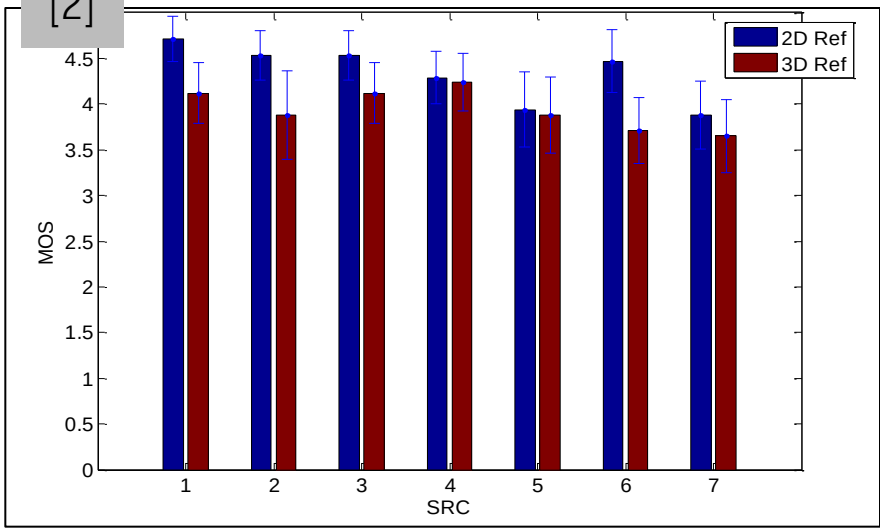
Motivation
Evaluating 3D QoE

- **Evaluation of overall 3D QoE is difficult**

[1]



[2]



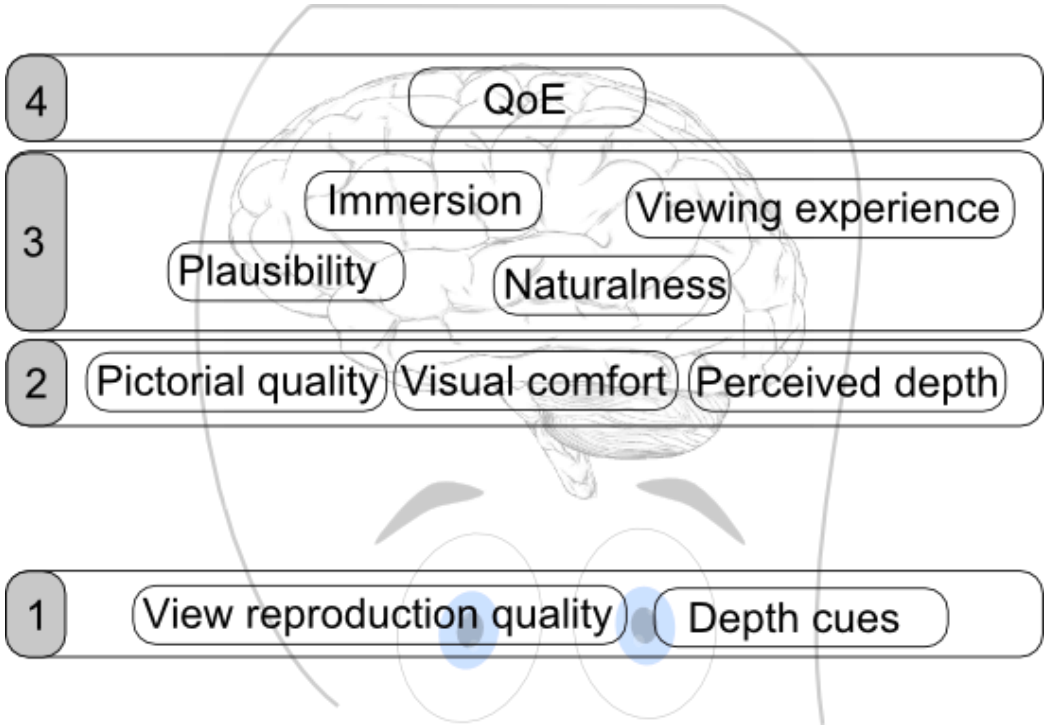
- **No statistical differences between 3D and 2D QoE ?**

[1] Brunnström, K.; Sedano, I.; Wang, K.; Barkowsky, M.; Kihl, M.; Andrén, B.; Callet, P. L.; Sjöström, M. & Aurelius, A. (2012), "2D No-Reference Video Quality Model development and 3D video transmission quality", International Workshop on Video Processing and Quality Metrics for Consumer Electronics (VPQM)', Scottsdale, Arizona, USA.

[2] Lebreton, P.; Raake, A.; Barkowsky, M. & Callet, P. L. (2011), "A subjective evaluation of 3D IPTV broadcasting implementations considering coding and transmission degradation'" IEEE International Workshop on Multimedia Quality of Experience, MQoE11', Dana Point, CA, USA.

Motivation

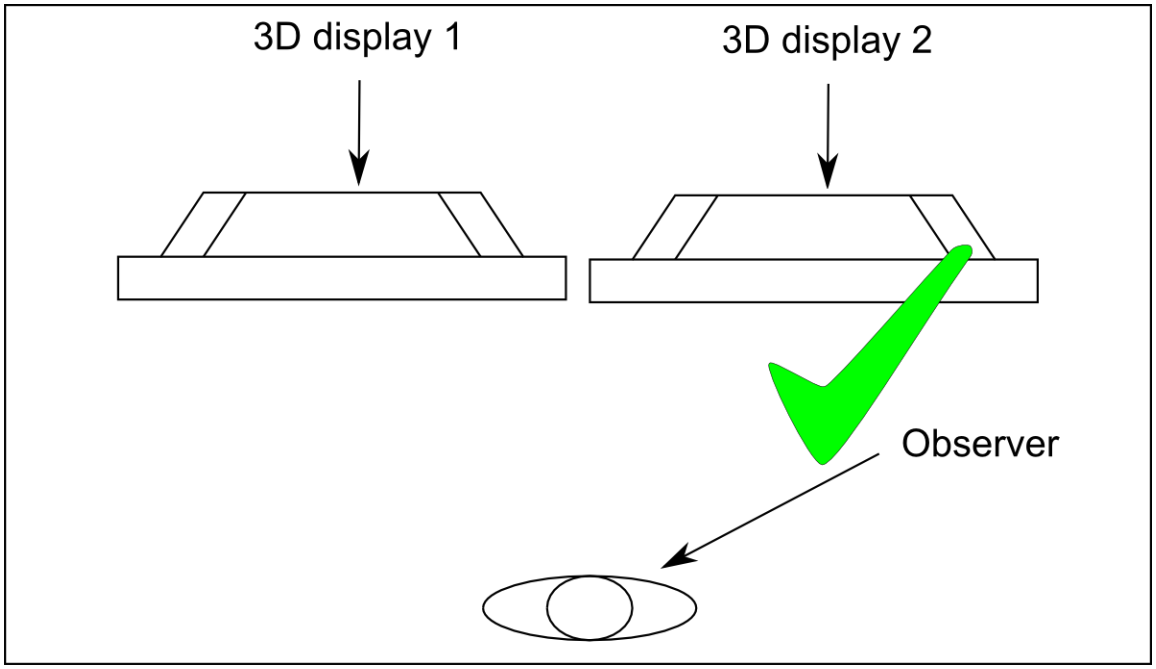
The use of others evaluation concept



- Evaluation of QoE using other evaluation concepts [1]
- How close these evaluation concepts are from QoE?
- Are your sure that people understand your question?

[1] **Seuntiëns, P. J. (2006), "Visual experience of 3D TV", PhD thesis, Eindhoven University.**

Motivation
The use of pairwise comparison



- Simple question: evaluation of preference between presentation!
- Take into account all factors involved in QoE

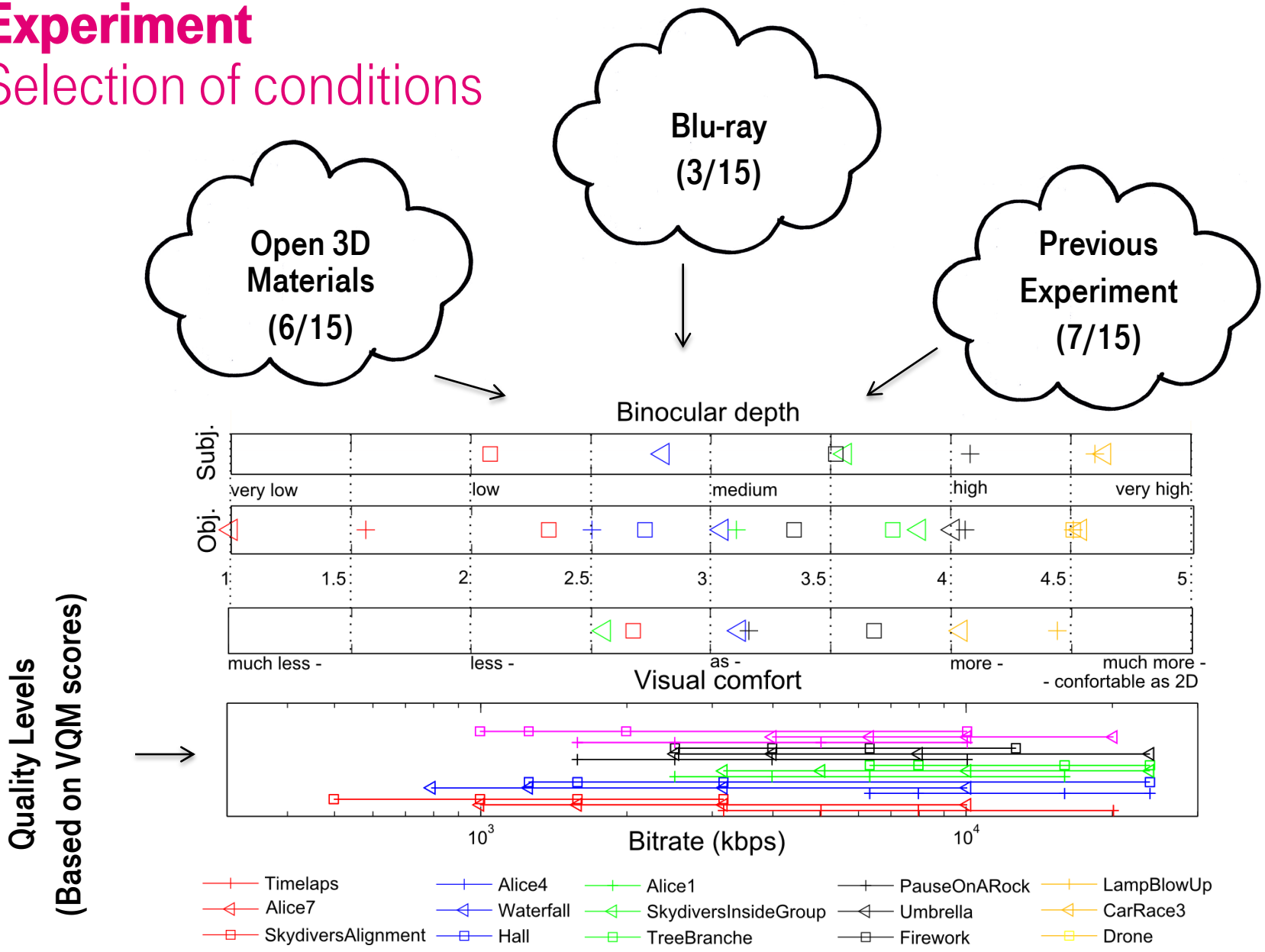
Outline

- Motivation
- **Experiment**
- Results
- Conclusion

Experiment
Research questions

- Evaluate the distance between 2D and 3D QoE?
- Preference of 3D over 2D depending on image quality and content characteristics?
- Content characteristics vs. Coding – Relative importance?

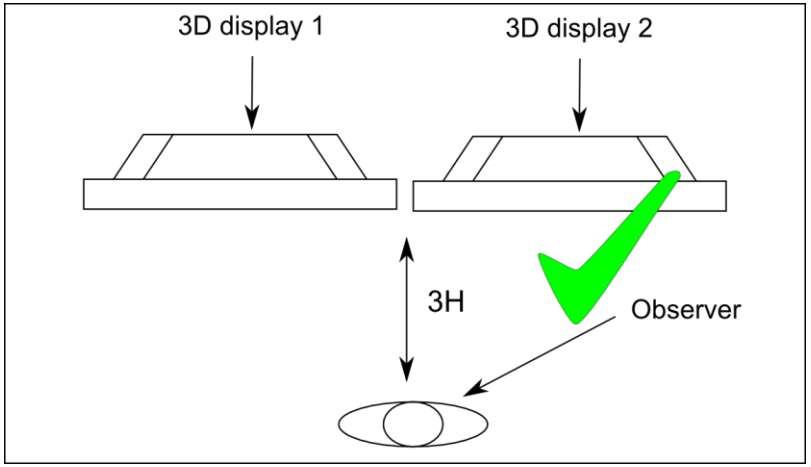
Experiment
Selection of conditions



Lebreton, P.; Raake, A.; Barkowsky, M. & Callet, P. L. (2012), 'Evaluating depth perception of 3D stereoscopic videos', *IEEE Journal of Selected Topics in Signal Processing* **6, 710-720.**

Experiment
Experimental setup

List of sequence pairs compared by observers					
3DQ4	vs	3DQ0	2DQ3	vs	2DQ1
3DQ4	vs	2DQ4	2DQ3	vs	3DQ2
3DQ0	vs	2DQ4	2DQ1	vs	3DQ2
3DQ3	vs	3DQ1	3DQ4	vs	3DQ3
3DQ3	vs	2DQ2	3DQ4	vs	2DQ3
3DQ1	vs	2DQ2	3DQ3	vs	2DQ3
3DQ0	vs	3DQ1	3DQ0	vs	2DQ1
3DQ1	vs	2DQ1	2DQ4	vs	2DQ2
2DQ4	vs	3DQ2	2DQ4	vs	2DQ4



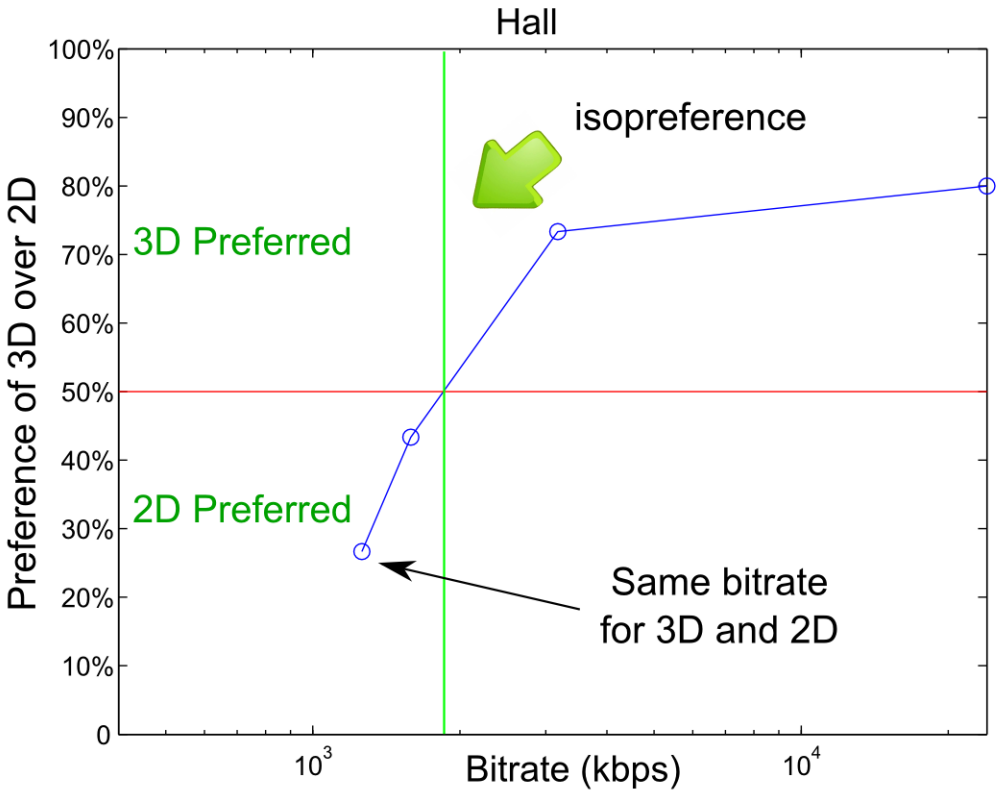
- **Comparing only several versions of the same content (intra-content comparison)**
- 23“ Polarized Display (Hyundai, Viewsonic V3D231) – calibrated display
- Randomization of trials (sequentially and displays presentation)
- 35 Observers (vision screened)

Outline

- Motivation
- Experiment
- **Results**
- Conclusion

Results

Preference of 3D over 2D in dependence of coding

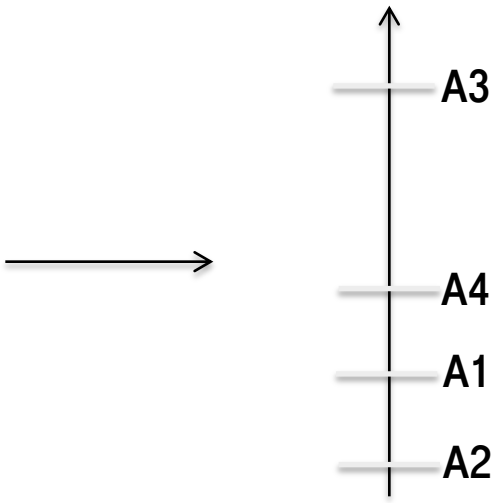


- **Preference** of 3D over 2D **increases** when pictorial **quality increase**
- On average, **isopreference** achieved with **VQM = 0.24**
- No clear relation was found with depth quantity

Results

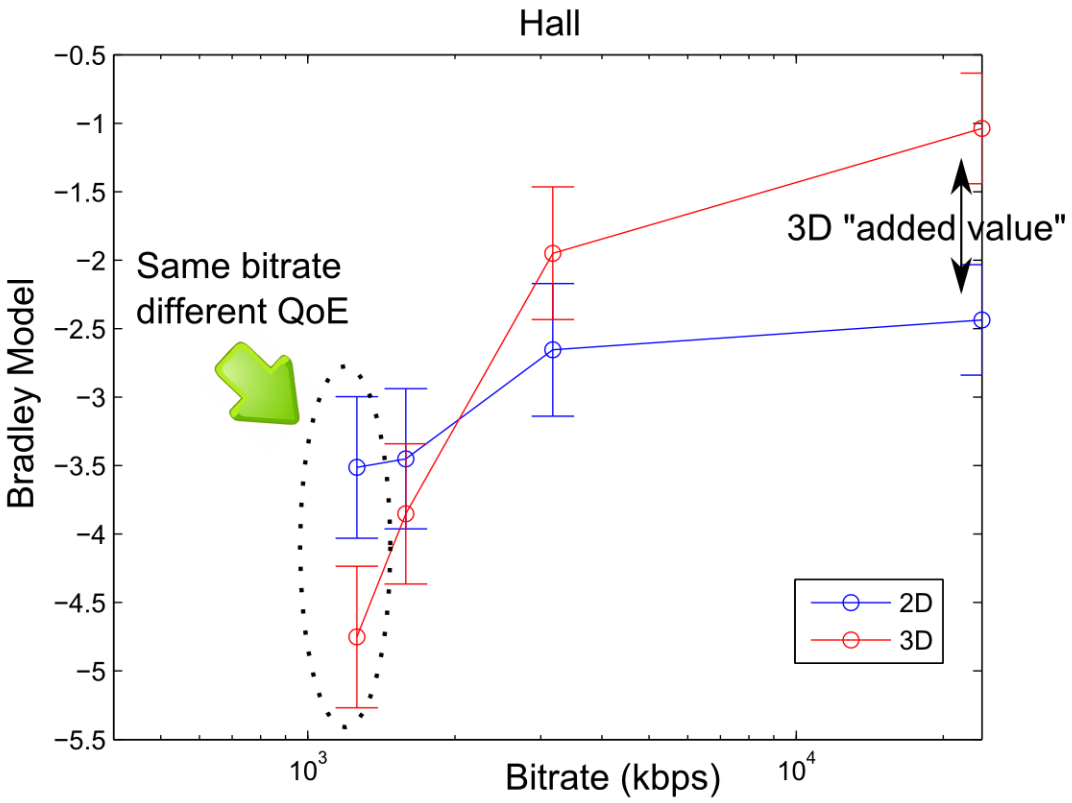
Mapping pairwise comparison data to a perceptual scale

	A1	A2	A3	A4
A1	-	46	29	48
A2	44	-	34	43
A3	61	56	-	50
A4	42	47	40	-



- Bradley model: Mapping of the preference to a continuous scale

Results
Quantitative preference of 3D over 2D

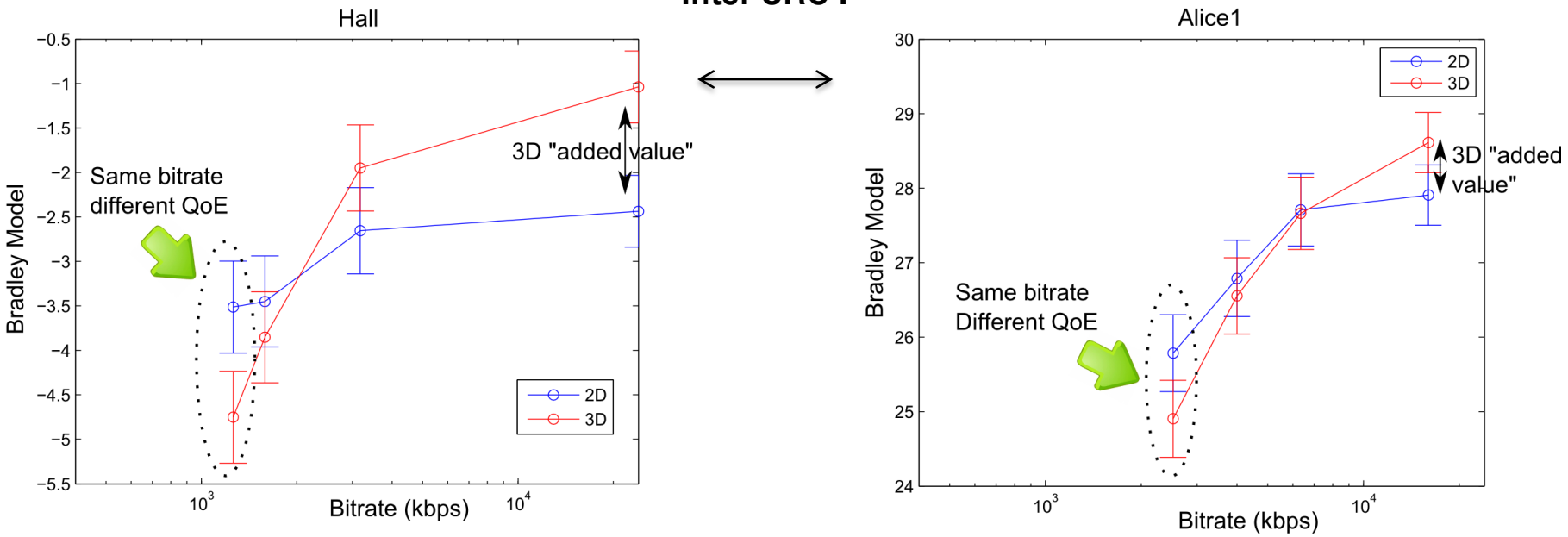


- Test design allowed to apply the Bradley model on the PC data → Quantitative evaluation
- Evaluation of the "**3D added value**"

Results
Limitation

BT-Scores not comparable

Inter-SRC !



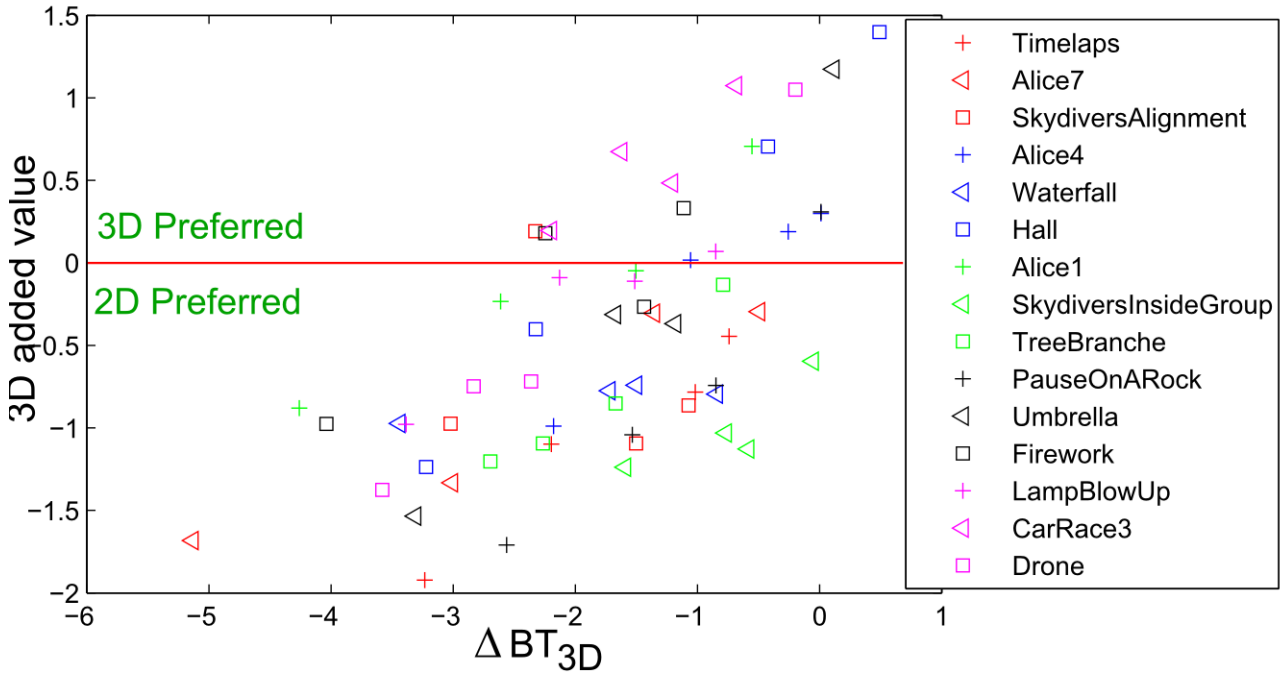
- Test design: PC intra sequences → No quantitative evaluation intra-sequences : unknown offset between BT-Score of different SRCs

➢ 3D Quality using ΔBT_{3D}: the difference between BT-Score of the 3D reference and 3D sequence

$$\Delta BT_{3D}(i) = BT_{3D}(i) - BT_{3D}(non\ encoded)$$

➢ Comparison of QoE though the "3D added value"

Results
Quantitative preference of 3D over 2D



- Increase of preference of 3D over 2D when quality increase
- High content dependency

Results

Quantitative relation between quality and “3D added value” (2)

$$3DAV = \alpha \cdot \Delta BT_{3D} + \beta$$

Content	α	β	Content	α	β
Timelaps	0.54	-0.10	Alice7	0.33	-0.07
Sky.Alignment	0.021	-0.94	Alice4	0.58	0.38
Waterfall	0.08	-0.67	Hall	0.68	1.05
Alice1	0.40	0.77	Sky.InsideGroup	0.38	-0.72
TreeBranche	0.57	0.23	PauseOnARock	0.76	0.13
Umbrella	0.76	-0.90	Firework	0.38	0.65
LampBlowUp	0.41	0.53	CarRace3	0.51	1.33
Drone	0.71	1.15	overall	0.71	1.15

Effect of codding on the “3D added value”

“Appropriateness” of the 3D material

- High content dependency: codding affect “3D added value” with a ratio from 0.08 to 0.76
- On average, a **ratio of 0.71** between **3D pictorial quality** and the **“3D added value”** was found

Outline

- Motivation
- Experiment
- Results
- **Conclusion**

Conclusion

- **Preference of 3D over 2D depends on image quality and content characteristics**
  - Increase of pictorial quality provide an increase of preference of 3D over 2D
  - On average, a VQM of 0.21 was needed to reach the isopreference between 2D and 3D

- **Content characteristics vs. Coding**
  - There is a high content dependency of the effect of “3D pictorial quality” on “3D added value”
  - On average, a factor of 0.71was found between the effect of coding and the “3D added value”

Further research

- **The explanation of the content dependency:**
  - It may depends on depth quantity, depth quality, and visual discomfort
  - Previous work on content characterization should be applied to explain these data

- **Content specificities and pictorial quality will be considered for 3D QoE prediction algorithm**

THANK YOU!

LIFE IS FOR SHARING.