HOCHSCHULE
DER MEDIEN

Research project winter semester 2024/25

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Exploring **Higher** and **Variable** Frame Rates

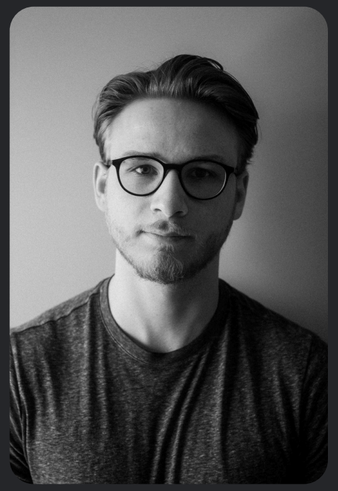
A Perceptual Case Study

Leonard Oberhauser

Team

Jeanine

Screenwriter /
Director / Producer



Arno

Director / Producer

Leonard

Operator /
Postproduction-
supervisor

Angelina

Director of
Photography

Katja

1st AC / Editor /
Set Design

Anastasia

Continuity /
Assistant Editor

Motivation

Credible storytelling with HFR in fictional films

Creation of film images with a focus on temporal resolution

HFR as an authoring tool

Camera and Workflow Tests

‘documentary style’ as anker point

ARRI Amira

Samyang Cine Lens Set & 1/4 Diffusion

DVTEC

Shoulder Rig

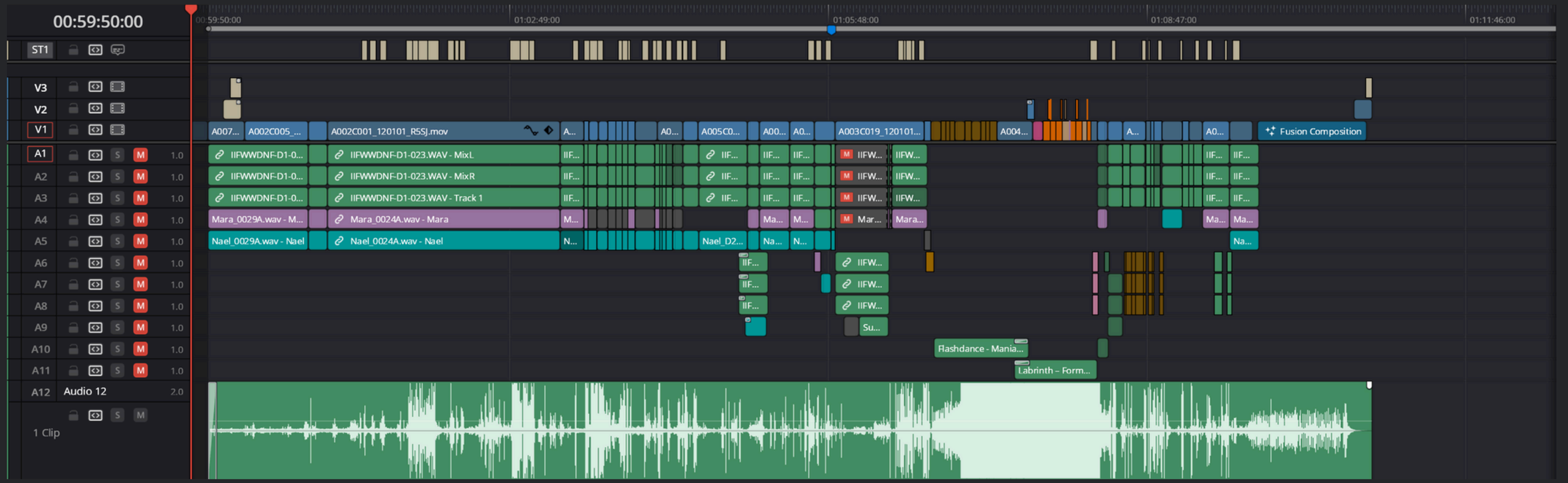
Learnings:

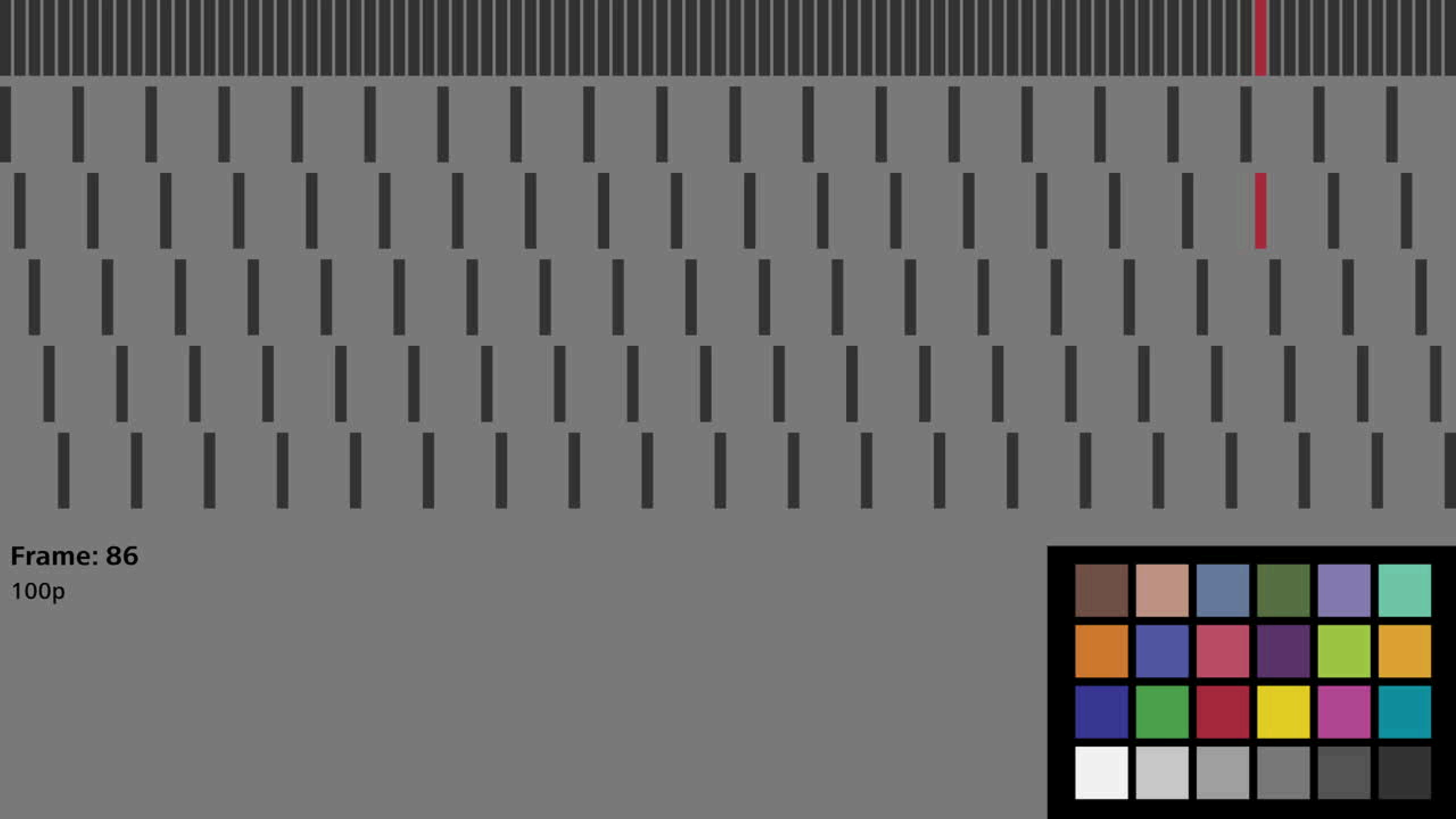
- Prioritisation of shallower depth of field
- Compressed background with longer lenses / getting close to actors
- Working aperture of T 2.0 and 100 fps
- 360° shutter for more motion blur and synthetic shutter options
- Handheld / Shoulder rig operating

Shoot

Postproduction

- Guarantee HFR real-time editing and playout
- Integrate an HFR-compatible monitor




Frame: 86
100p

Frame Interpolation

- Tool for frame interpolation and motion blending
- Customisable motion blur and frame rate
- Transitions with keyframes adjustable over time

Daniel Grootz, Jan Hoydem & Martin Hübsch

ICH FÜHLE WAS, WAS DU NICHT FÜHLST

DREHBUCH JEANINE LANG REGIE JEANINE LANG, ARNO LINDNER
PRODUKTION ARNO LINDNER, JEANINE LANG DIRECTOR OF PHOTOGRAPHY ANGELINA CHINDEMI
OPERATOR LEONARD OBERHAUSER KAMERAASSISTENZ KATJA RIEGER OBERBELEUCHTER MAXIMILIAN CAPELLER
BEST BOY OSMAR WONG SZENENBILD KATJA RIEGER MASKE MANDY BAO NGHI TRAN
AUFNAHMELEITUNG ALIENA LEONHARD ORIGINALTON KAIDEN CRAIGH SCRIPT SUPERVISOR ANASTASIA KIM
SETRUNNER TIMON HAUG MONTAGE KATJA RIEGER, ARNO LINDNER, LUKAS SCHOENENBERG,
ANASTASIA KIM FILMMUSIK LINDA QUAST, JAMAL ULBRICHT SOUNDDESIGN JULIAN FERREIRA DA SILVA,
FELIX STÖCKL MISCHUNG DANIEL KNÜTTEL COLORIST MICHAEL BEIL
POSTPRODUKTIONSSUPERVISOR LEONARD OBERHAUSER STANDFOTOGRAFIE ALIENA LEONHARD

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SFR	25 FPS
HFR	100 FPS
VFR	25-100 FPS

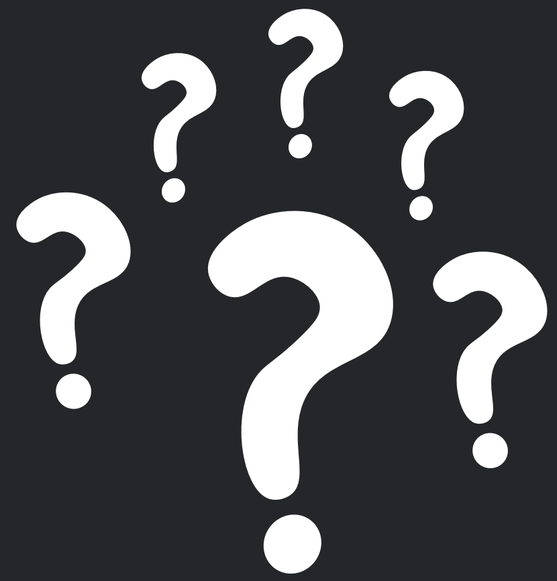
Study - Research Questions

1. What are the differences in the perceptions and evaluations of HFR and SFR sequences?

2. Which role do camera movement and focus/depth of field play in the evaluation of SFR and HFR?

3. What are the differences in the perception of VFR sequences with and without frame rate ramps?

4. How does the individual viewing experience influence the perception of the frame rate?



Study Design

Type of study

- Mixed Methods
- Exploratory and quantifiable
- Qualitative and quantitative approaches

Participants

- Group study with 65 participants
- 6 screenings with 10-15 participants each
- Controlled laboratory environment

Subject of study

- 8 specific sequences
- Variety of characteristics:
  - Cut frequency, shot length & camera and actor movements
- Screenings differ in frame rate versions

Subject of Study

Sequence	Content	Characteristics	Frame Rate versions	Frame Rate versions
Calm 1	Mara wakes up	cuts: few, shots: long, camera / actor movement: limited	group 1: HFR group 2: SFR	frame rate effects on content and image aesthetic
Calm 2	The couple puzzles	cuts: few, shots: long, camera / actor movement: limited	group 1: HFR group 2: SFR	frame rate effects on content and image aesthetic
Varied 1	Nael massages Mara	cuts: various, shots: shorter, actor movement: some	group 1: SFR group 2: HFR	frame rate effects on content and image aesthetic
Varied 2	The couple dances	cuts: various shots: shorter, camera / actor movement: strong	group 1: SFR group 2: HFR	frame rate effects on content and image aesthetic
Varied 3	The couple has an argument	hots: shorter, camera / actor movement: limited	group 1: SFR group 2: HFR	frame rate effects on content and image aesthetic
Calm 3	Nael reads his flashcards to Mara	cuts: few, shots: long, camera / actor movement: limited	group 1: VFR with ramps group 2: VFR with cuts	frame rate changes and effects on content and image aesthetic
Varied 4	Nael massages Mara	cuts: various, shots: shorter, actor movement: some	group 1: VFR with ramps group 2: VFR with cuts	frame rate changes and effects on content and image aesthetic
Varied 5	The couple dances and Maras ecstatic dance	slow motion transition, cuts: various, shots: shorter, camera / actor movement: strong	group 1: VFR with ramps group 2: VFR with cuts	frame rate changes and effects on content and image aesthetic

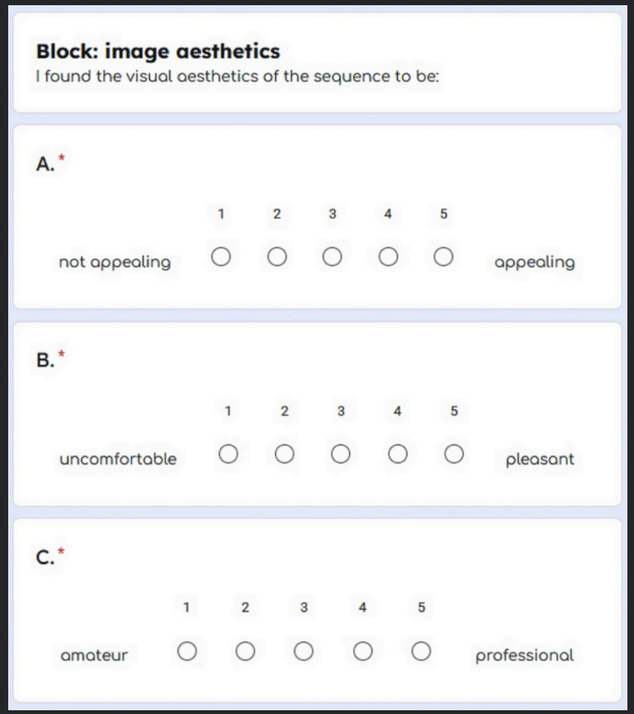
Procedure and Questionnaire

Procedure:

- 6 screenings devided into two groups
- Depending on frame rate version
- Order of sequences is varied

Questionnaire:

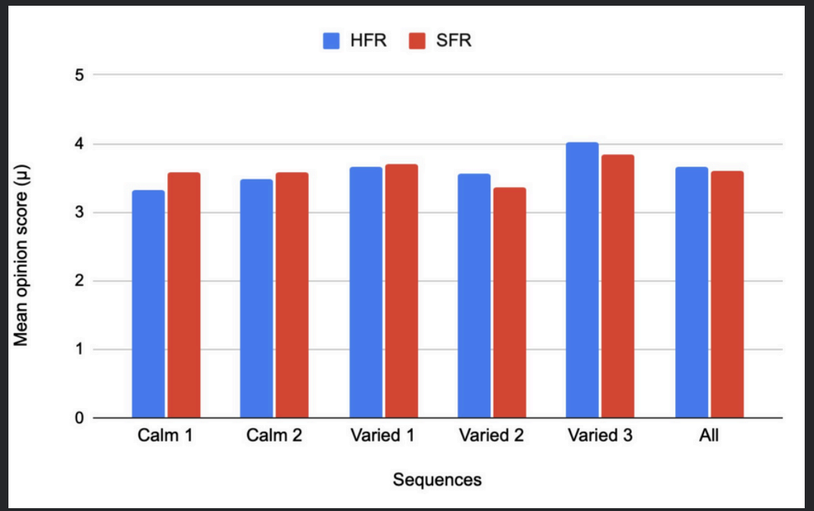
- Divided into two aspects ‘image aesthetics’ and ‘story-content’
- Rating scales querying for contrasting word pairs
  - Based on literature
- In Addition: Text fields for impressions and open questions



Results
Comparison of the Perception of HFR and SFR

- No significant difference when averaging ratings across all film sequences
  - Preference may depend on scene charasteristics and content

- Significant difference in content-related ratings of quiet sequences with long-lasting shots
  - Quiet sequences with long-lasting shots receive a higher MOS in the SFR version



Results

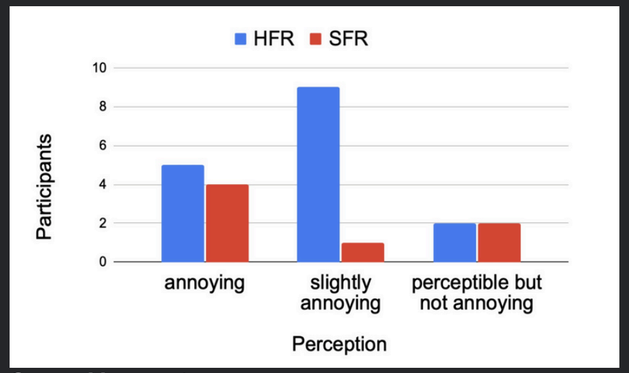
Influence of Cinematography on the Perception of HFR and SFR

Camera Movement:

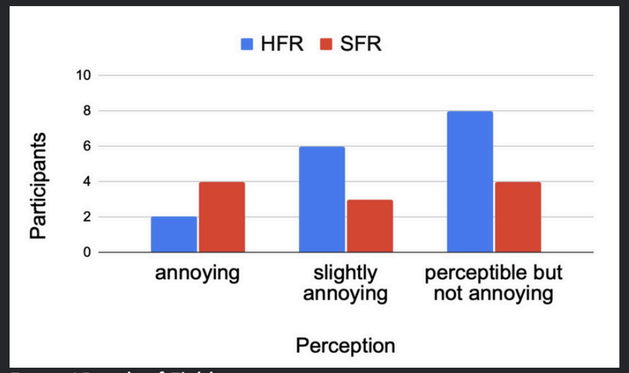
- HFR is categorised as little more ‘annoying’ than SFR
- Participants approve HFR significantly more often ‚slightly annoying‘ than SFR

Depth of Field:

- Notable discrepancy in the perception of focus and depth of field
- In HFR, focus and depth of field is perceived as less annoying than in SFR



Camera Movement

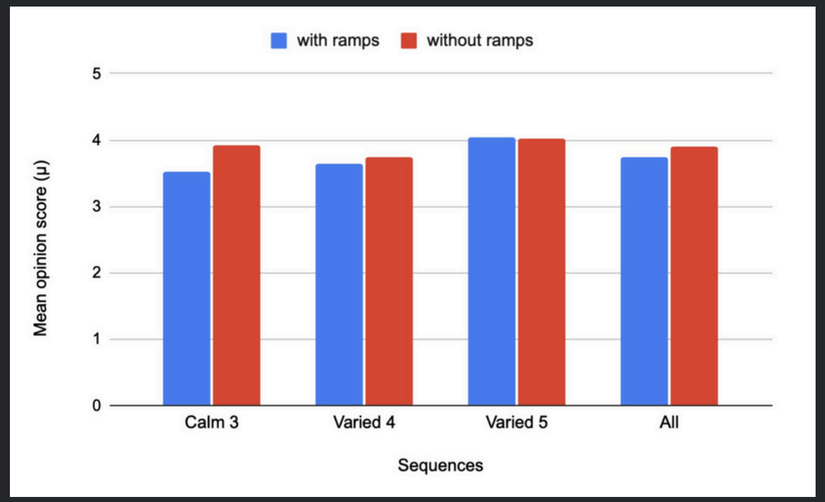


Focus / Depth of Field

Results

Evaluation of VFR Sequences and Frame Rate Ramps

- No perceptible significant difference when comparing all sequences with and without frame rate ramps
- Significant difference in sequence with long-lasting shots, few cuts and limited actor and camera movement
  - Higher MOS for VFR without frame rate ramps



Results

Relation Between Frame Rate Preference and Viewer Experience

- Significant difference in average ratings for participants with previous HFR viewing experience
  - Lower ratings by participants with HFR viewing experience
- HFR-experienced participants may be more disturbed by the image artifacts caused by 25 fps

- Significant difference in the rating of the VFR versions by cinema-goers
  - Ratings of VFR versions with ramps are significantly lower
- Cinema-goers are used to abrupt changes such as cuts
  - Common element of traditional film language

Dependencies for Suitable Frame Rate Choice

Results imply slight preference for SFR in calm film sequences...

Findings:

1

Long takes and high depth of field

- Distraction in HFR, as the viewer concentrates on unimportant details

2

Hand-held camera movements

- Minor camera movements can be perceived as more disturbing in HFR (e.g. micro-jitter)

3

Extended shot durations

- More time to perceive visual imperfections and distracting elements, resulting in a hyper-realistic impression in HFR

Dependencies for Suitable Frame Rate Choice

...and a preference for HFR in dynamic film sequences

Findings:

4

Shorter takes and faster cuts

- Faster editing style and shorter shots might reduce hyperrealistic impressions

5

Enhanced detail perception

- Improved clarity in fast pace sequences helps to follow the action

Dependencies for Suitable Frame Rate Choice

Variable Frame Rates

Findings:

6

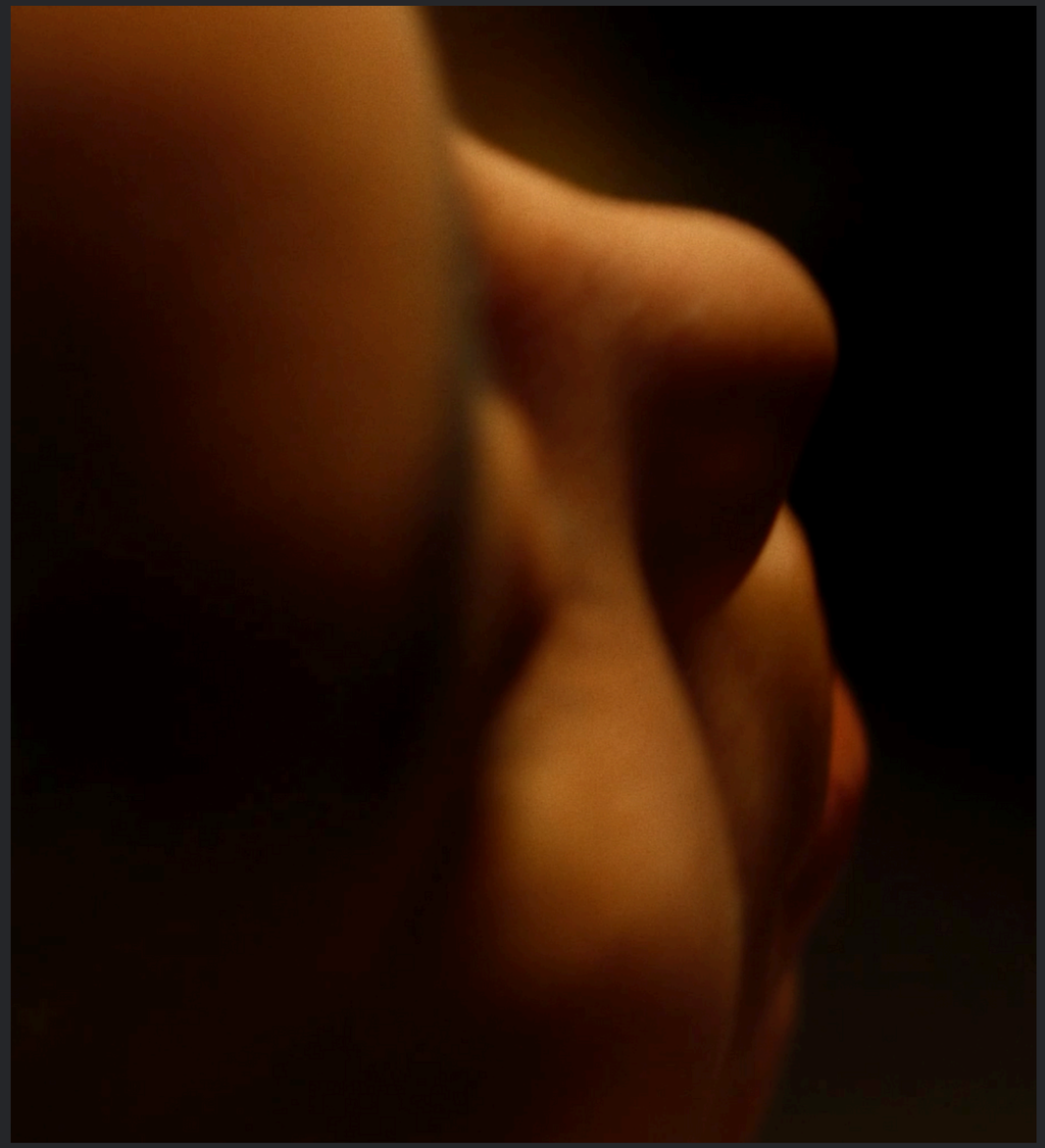
Stronger visual distinction

- Slight preference for VFR sequences without frame rate ramps over smooth transitions with ramps
- Could help viewers focus more on the story's context

7

No mention in free-text responses

- Uncertain how much the preference is influenced by the presence or absence of frame rate ramps



Thank you for your attention!

Your feedback and questions are welcome!

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