Simulation et Applications Interactives

Perceptually Based Graphics

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Overview

- Human Perception
- Perceptual Evaluations / Studies
- Examples

Human Perception

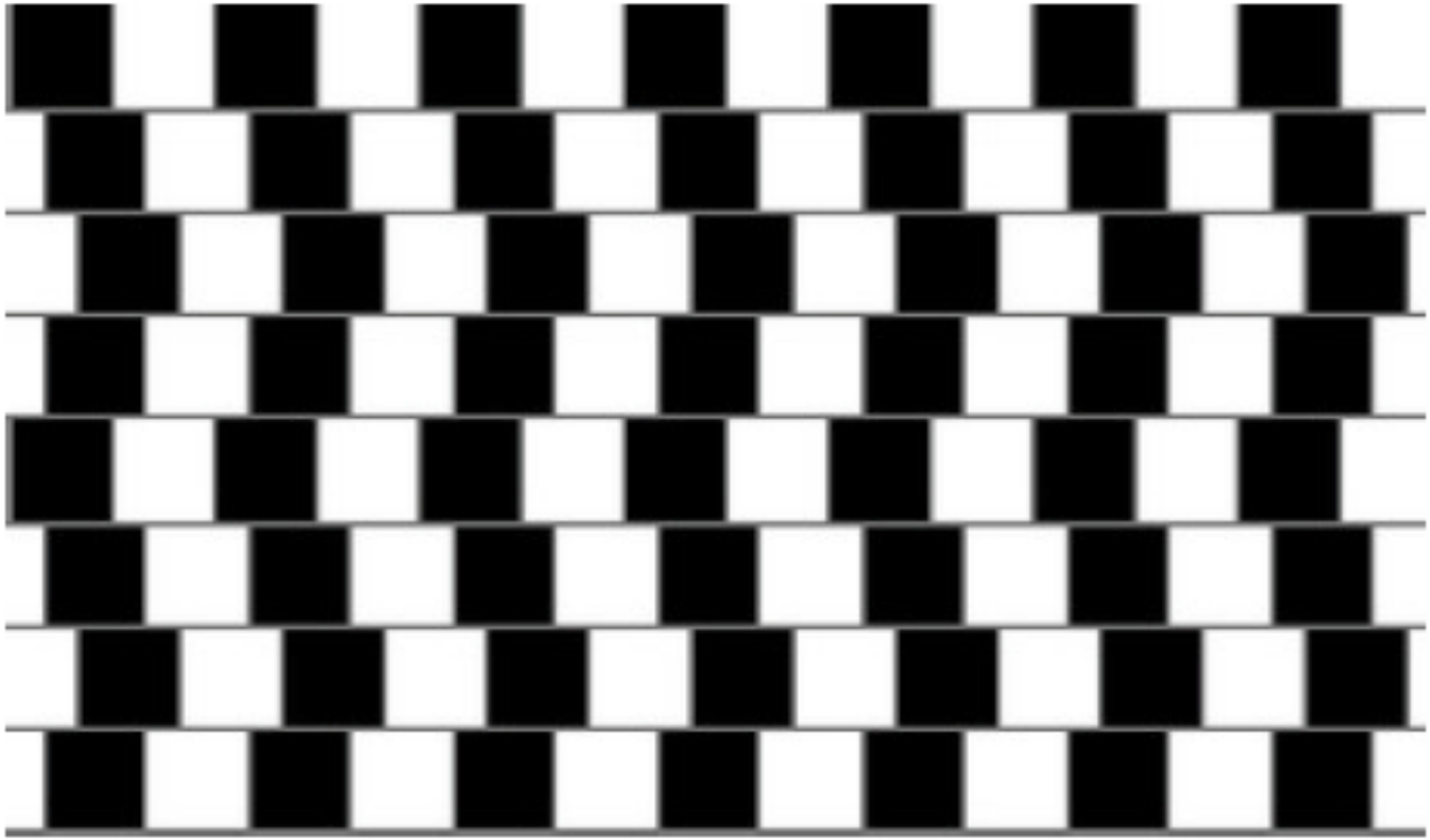
Definition

- What is perceptually based graphics?
  - Human Perception

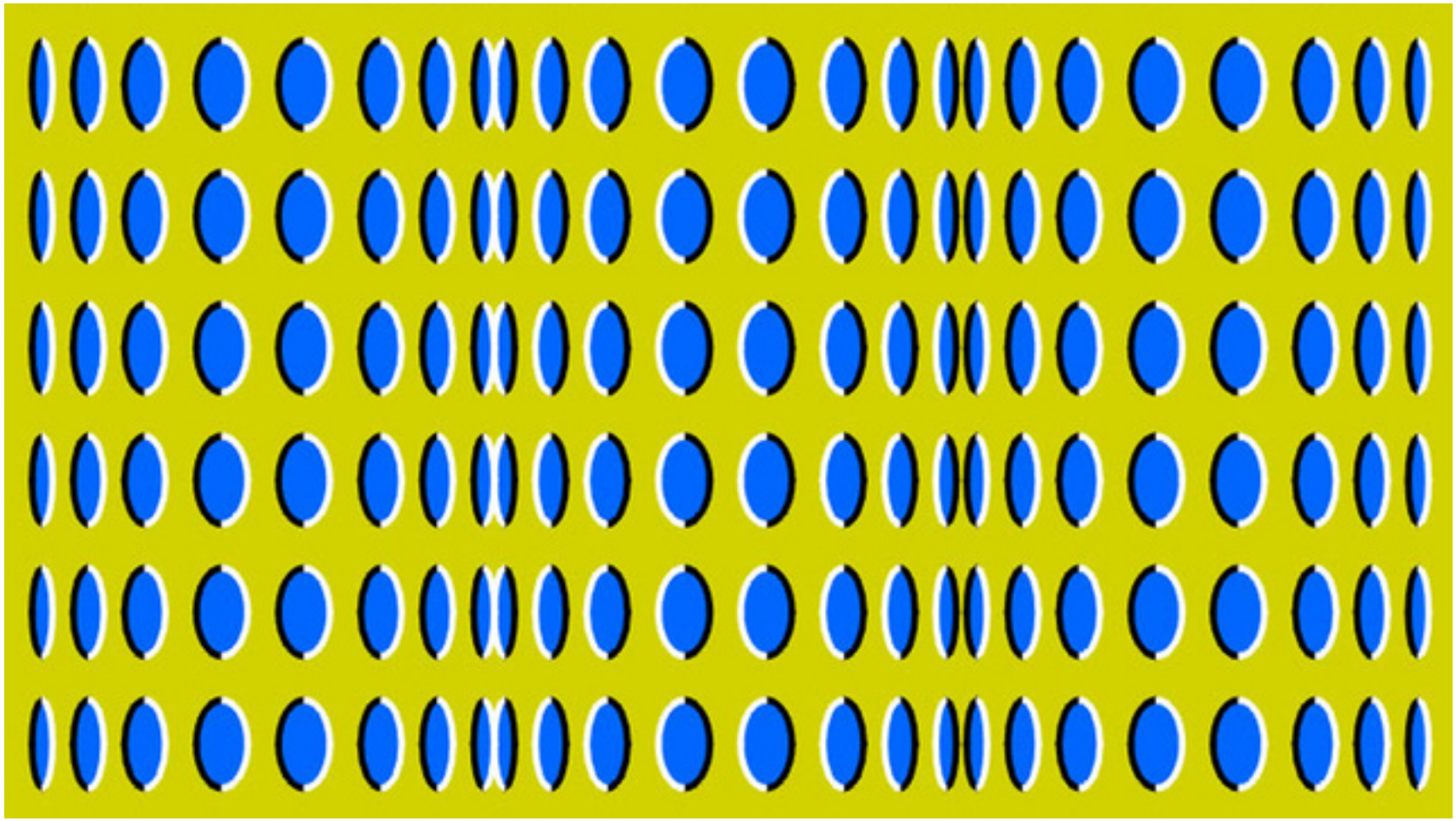
Why ?

- Human eye defects
  - No need to simulate what we cannot perceive
  - Rendering: central vision is more accurate than peripheral vision
  - Animation: most sensible to errors in translation than in rotation
- Wrong believes / Errors
- Saliency
- Uncanny valley

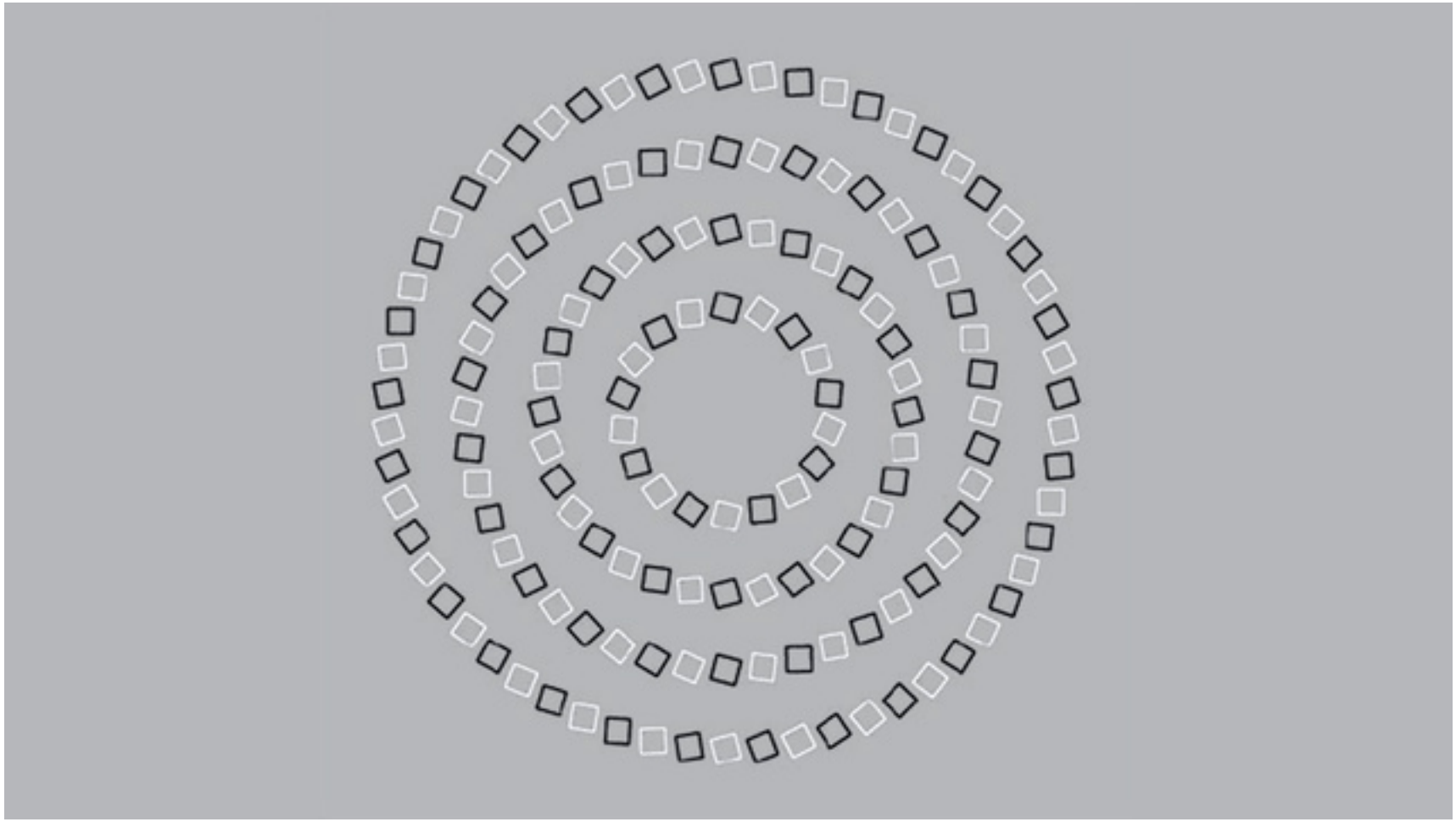
Eye Defect ?



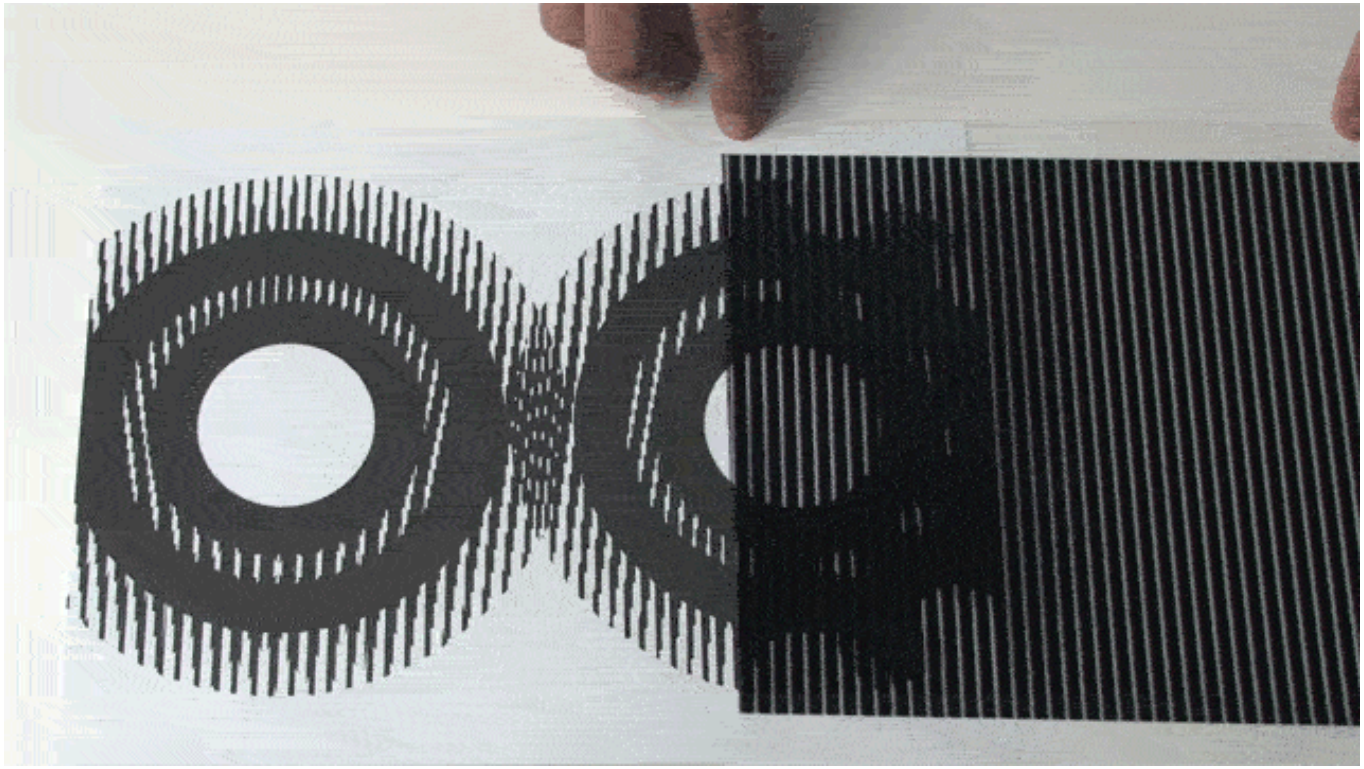
Perceptual Effect ?



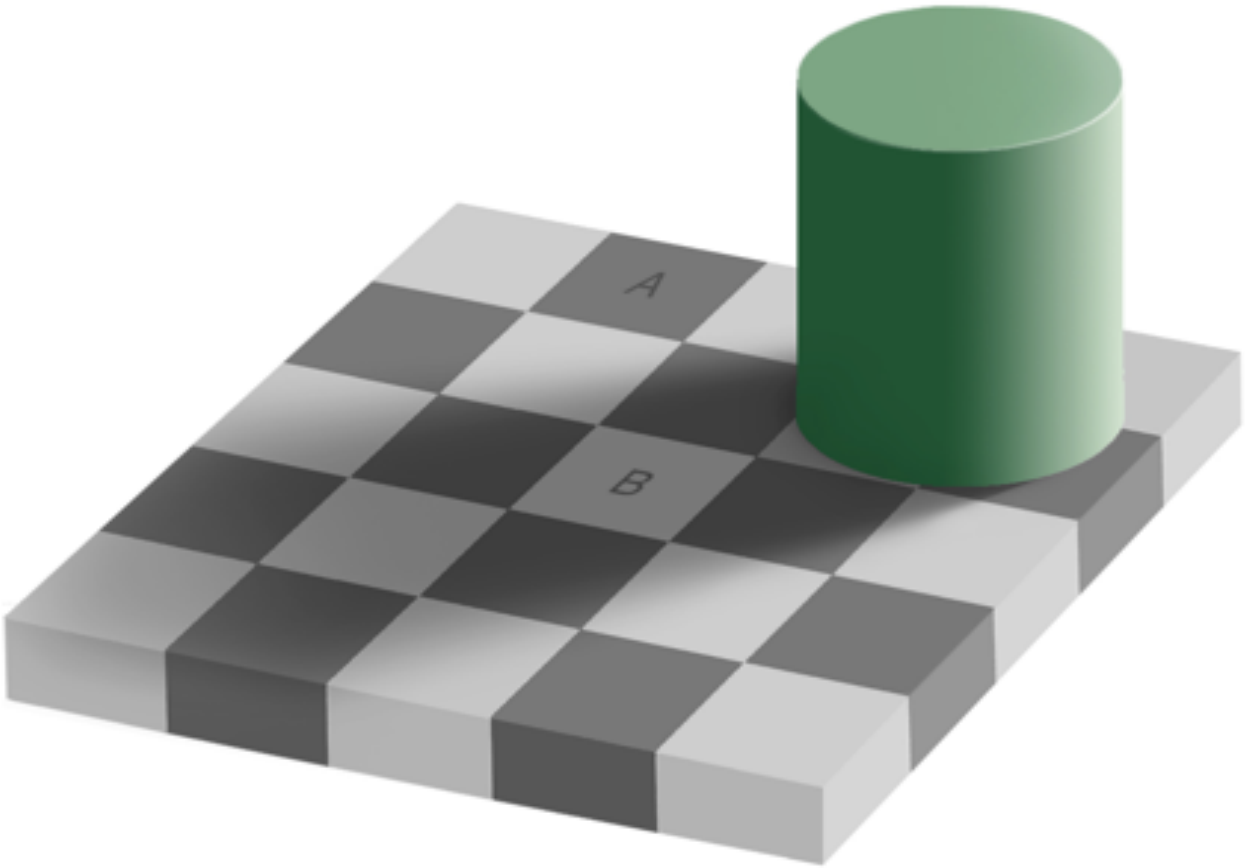
Biased Perception



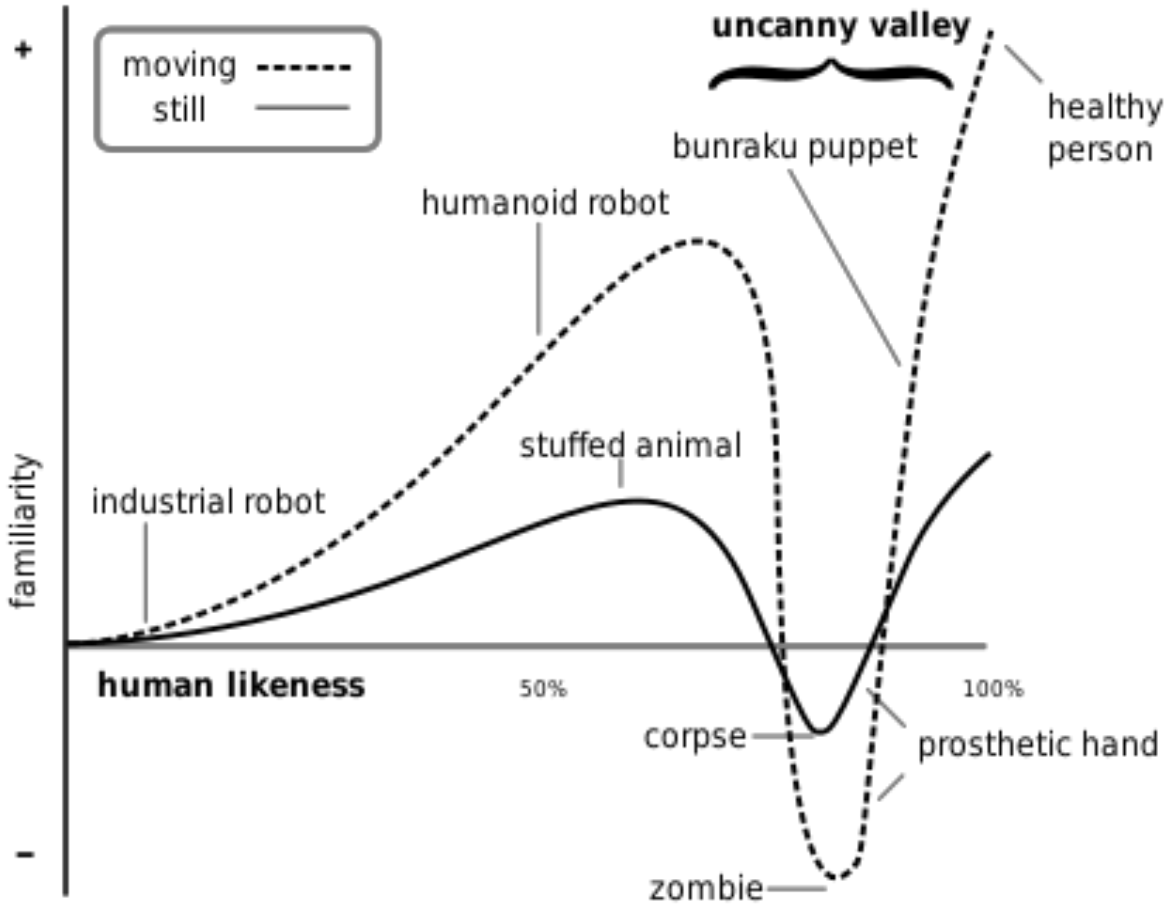
Animation ?



Color Perception



Uncanny Valley



Perceptual Evaluations / Studies

Aim

- Derive metrics / rules to build efficient algorithms
  - Faster
  - Less resources
  - More perceptually accurate / more credible
- Create LODs and transitions between LODs

How ?

1. We make test experiments
2. We run full experiments
3. Additional experiments if necessary to refine the findings
4. Get results / analyse
5. Make rules / metrics
6. Make algorithm using those rules

Methodology

- Parameters identification (baseline study)
- Generation of samples with independent variables
- Grading (direct/indirect)
- Analysis

Experiments

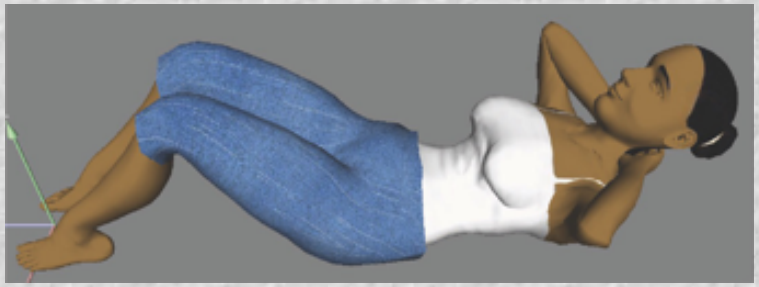
- In computer animation or games:
  - Clips of videos (2 to 5 seconds)
  - Grading or Sorting
  - Analysis with ANOVA (ANalysis Of VAriance)

Example 1
Dynamic Wrinkles

Dynamic Wrinkles

- Question: Are dynamic wrinkles important for realism ?

- Study of dynamic wrinkles of clothes in a game environment



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Study

"Do dynamic wrinkles make an animation look more realistic" ?

- Framework
- Variables
- Results

Framework

- 2 studies, 30 persons each
  - 18 to 58 years old
  - Various backgrounds
  - Normal vision

Framework

2 studies, 30 persons each

Luminosity fixed

- Room Illumination
- Default OpenGL ambient rendering

Framework

2 studies, 30 persons each

Luminosity fixed

Distance fixed to keep spatial frequency

- Character to camera
- Participant to screen

Framework

2 studies, 30 persons each

Luminosity fixed

Distance fixed

Background color = average of texture colors

Framework

2 studies, 30 persons each

Luminosity fixed

Distance fixed

Background color = average of texture colors

Videos at 24 fps MPEG-2 Blu-Ray

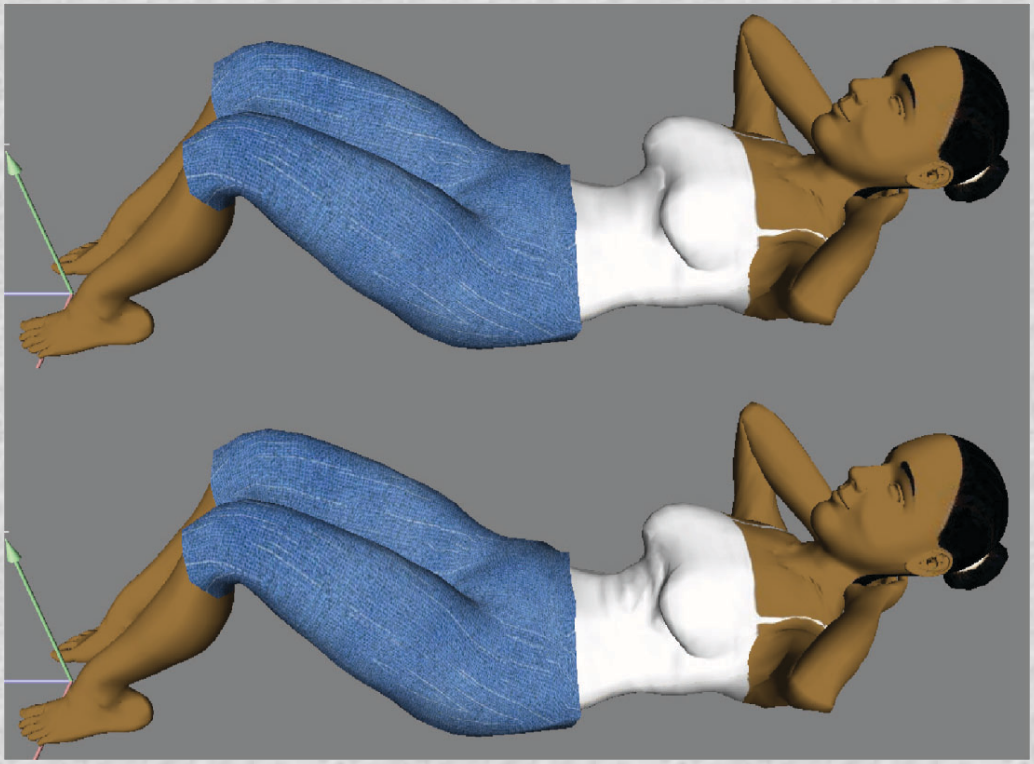
Framework

- **Wrinkles manually added** [Lar04a]
  - **On the tank top of the character**
  - **On the trousers in the front and in the back**
- **Video sequence randomly chosen**
- **Grade each video from 1 not realistic to 7 highly realistic**
- **ANOVA with 3 intra-participant factors**

2 Types of Skinning

With Dynamic Wrinkles

Without Dynamic Wrinkles



3 Types of Animation

Abdominals Animation

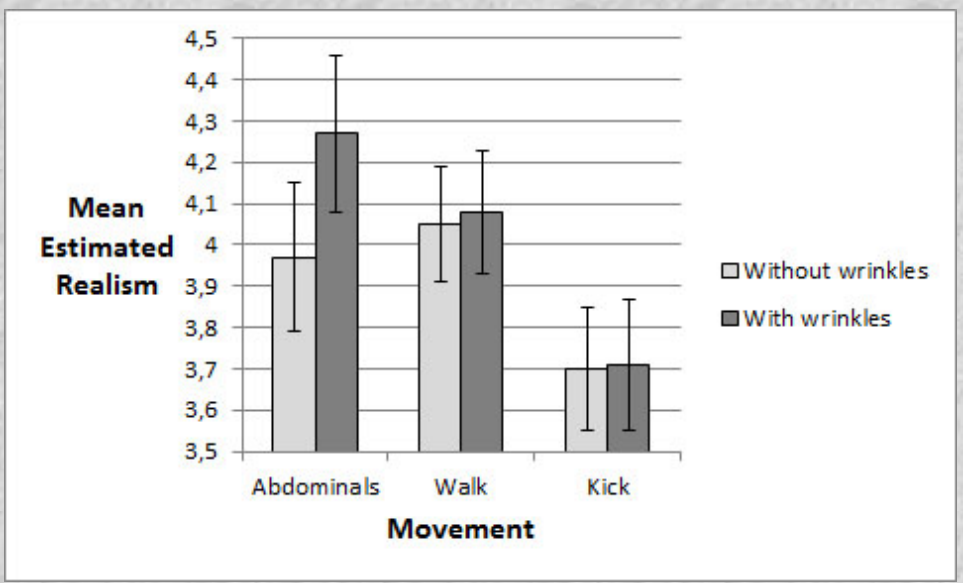
Walk Cycle

Kick-Boxing Animation

Result 1

Dynamic wrinkles always increase realism

Dynamic wrinkles are more important on slow movements



6 Different Angles

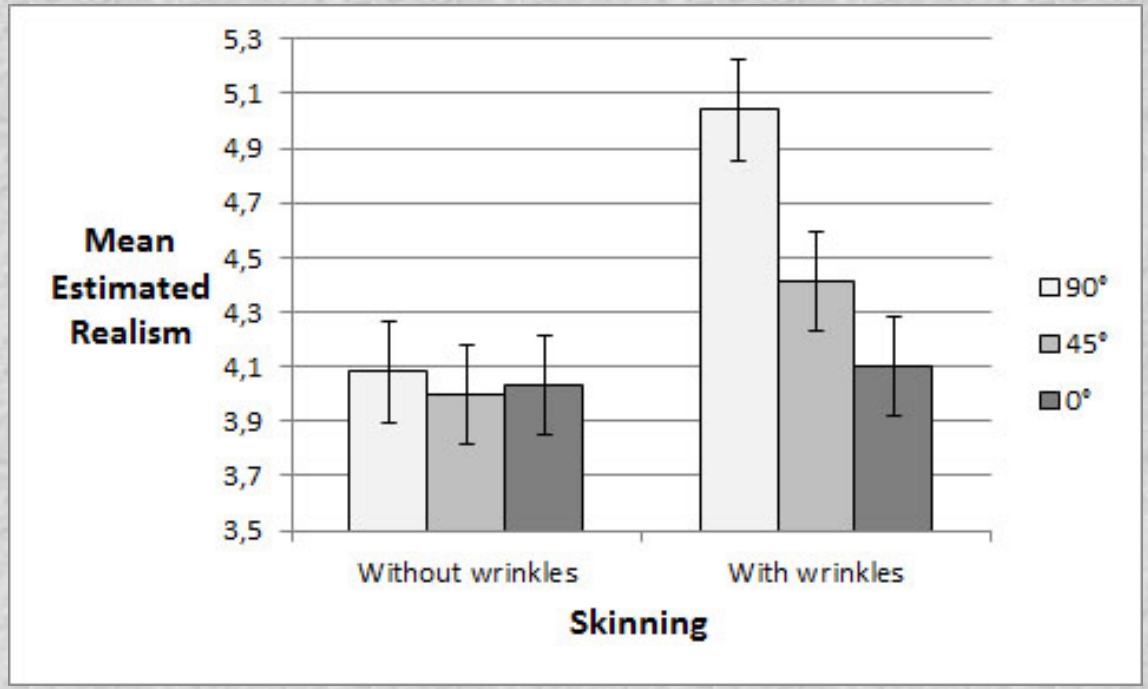
90 & -90 degrees

45 & -45 degrees

0 degrees twice

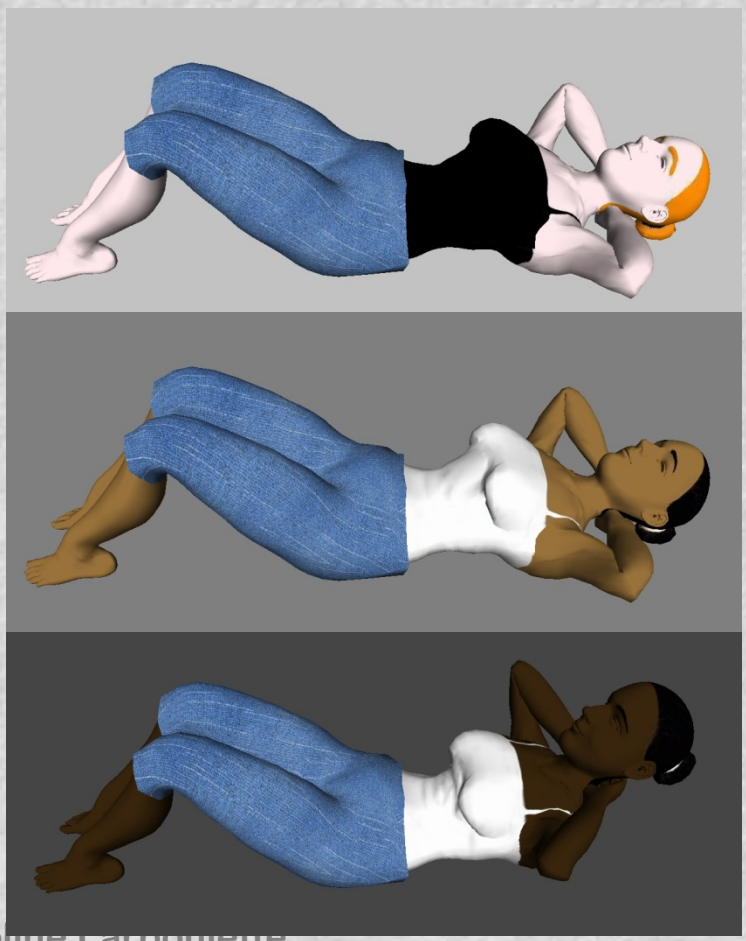
Result 2

With Dynamic Wrinkles, realism increases when viewing angle increases (from the side)



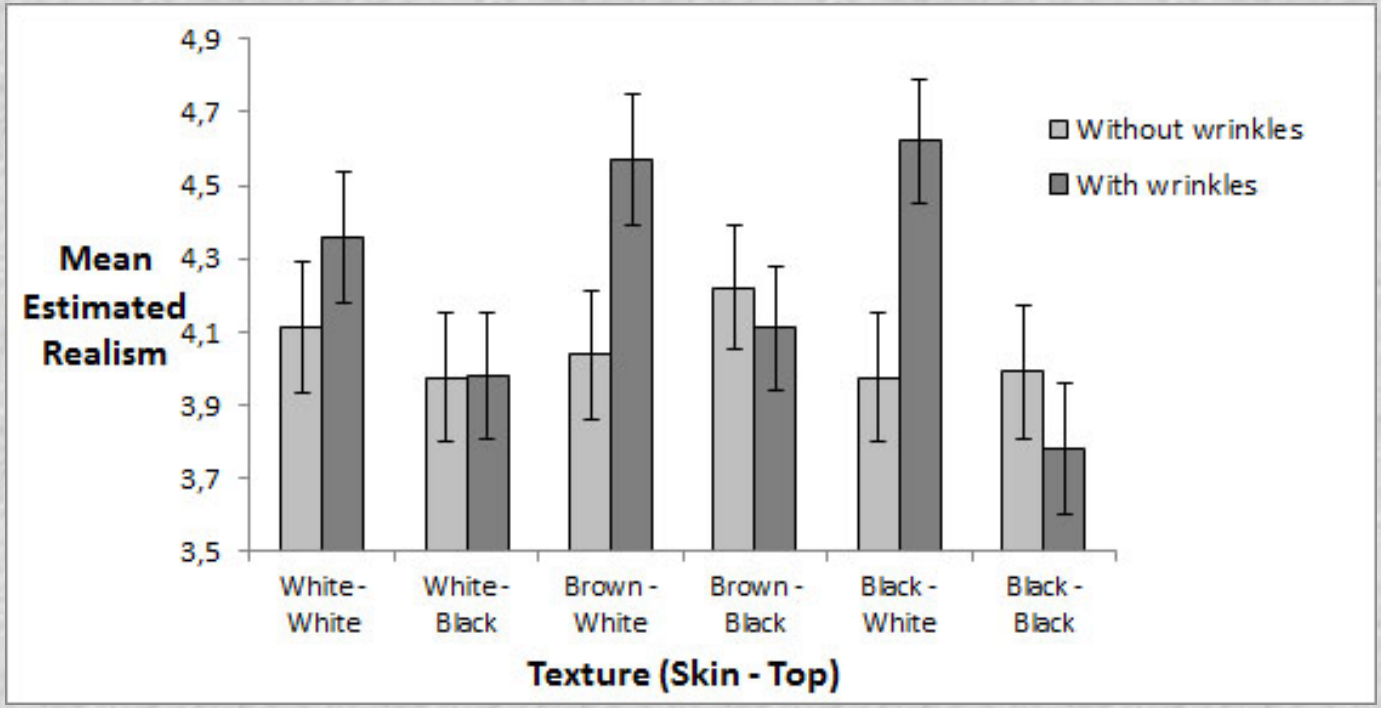
6 Different Colors

- **Skin**
  - White
  - Yellow
  - Black
- **Top**
  - White
  - Black



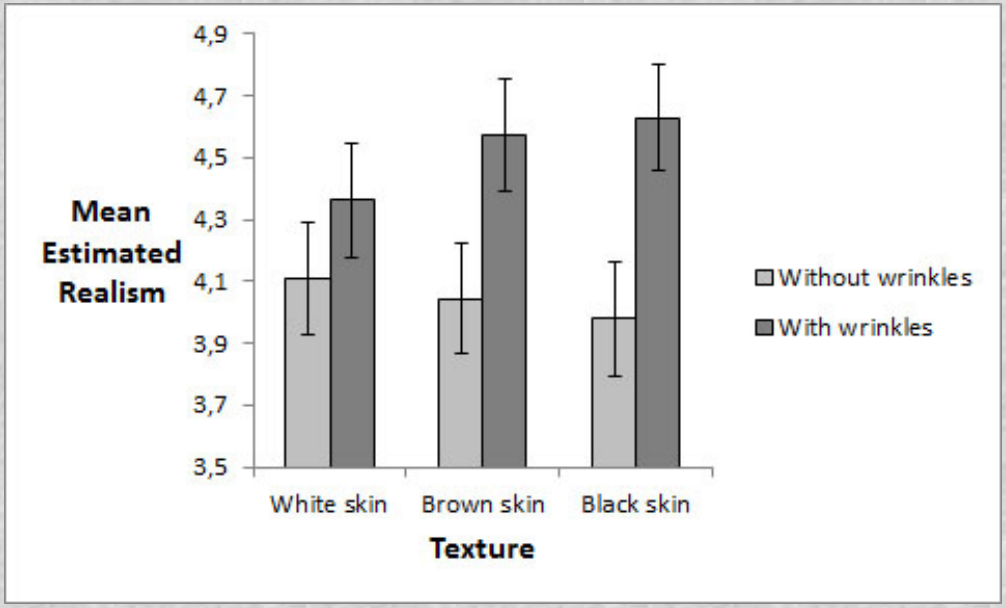
Result 3

Dynamic Wrinkles increase realism more onto bright surfaces than onto dark surfaces



Result 4

Skin color influences Dynamic Wrinkles perception: the more contrast overall, the more important the wrinkles



Conclusion

Wrinkles are important for realism

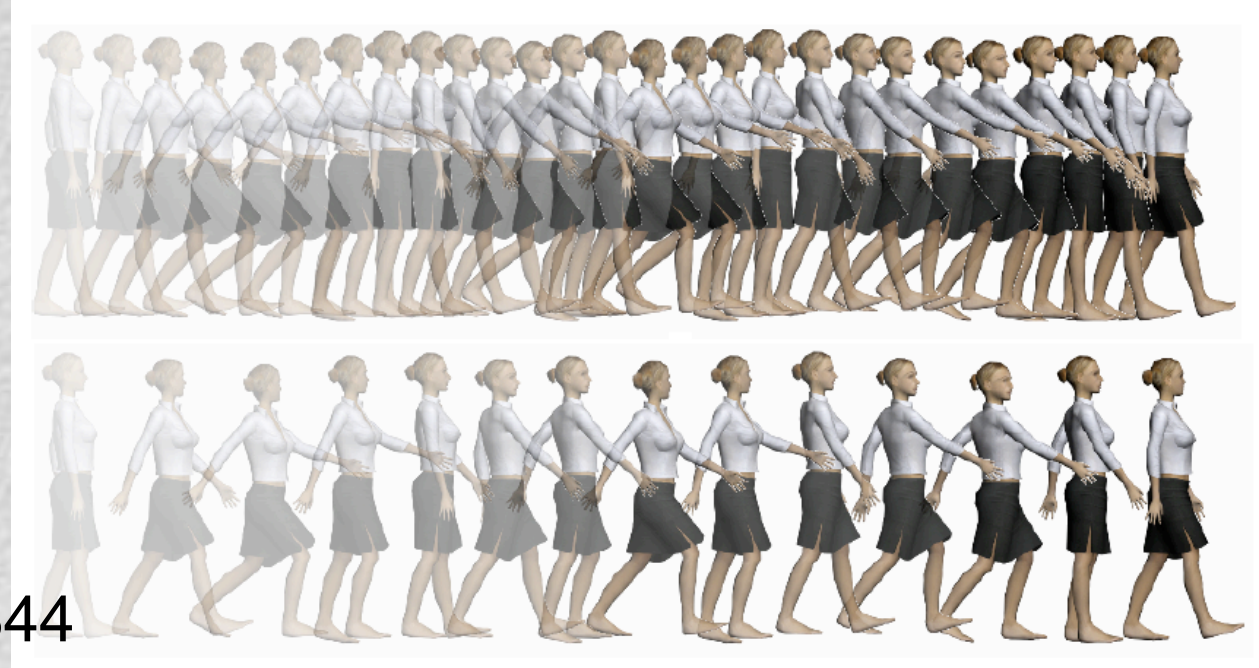
- On slow movements
- Seen from the side
- Onto bright surfaces
- When the constrast in the image is high

Example 2
Smooth Movers

Smooth Movers: Perceptually Guided Human Motion Simulation. Rachel McDonnell, Fiona Newell and Carol O'Sullivan. Eurographics / ACM SIGGRAPH Symposium on Computer Animation 2007.

Number of poses

- Question: what is the minimal number of poses for a movement to appear smooth ?



Baseline Experiment

Does the sex / quality of the clothes of the character influence the results ?

Baseline Experiment

Does the sex / quality of the clothes of the character influence the results ?

No !

Baseline Experiment

- Does the type of movement (walk, run, kick-boxing …) influence the results ?

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Baseline Experiment

- Does the type of movement (walk, run, kick-boxing …) influence the results ?

- Yes !

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Results

- Whatever the movement, it's always perceived smooth at 40pps
- If people are in the foreground, 30pps is sufficient
- If people are in the background, 16pps is sufficient

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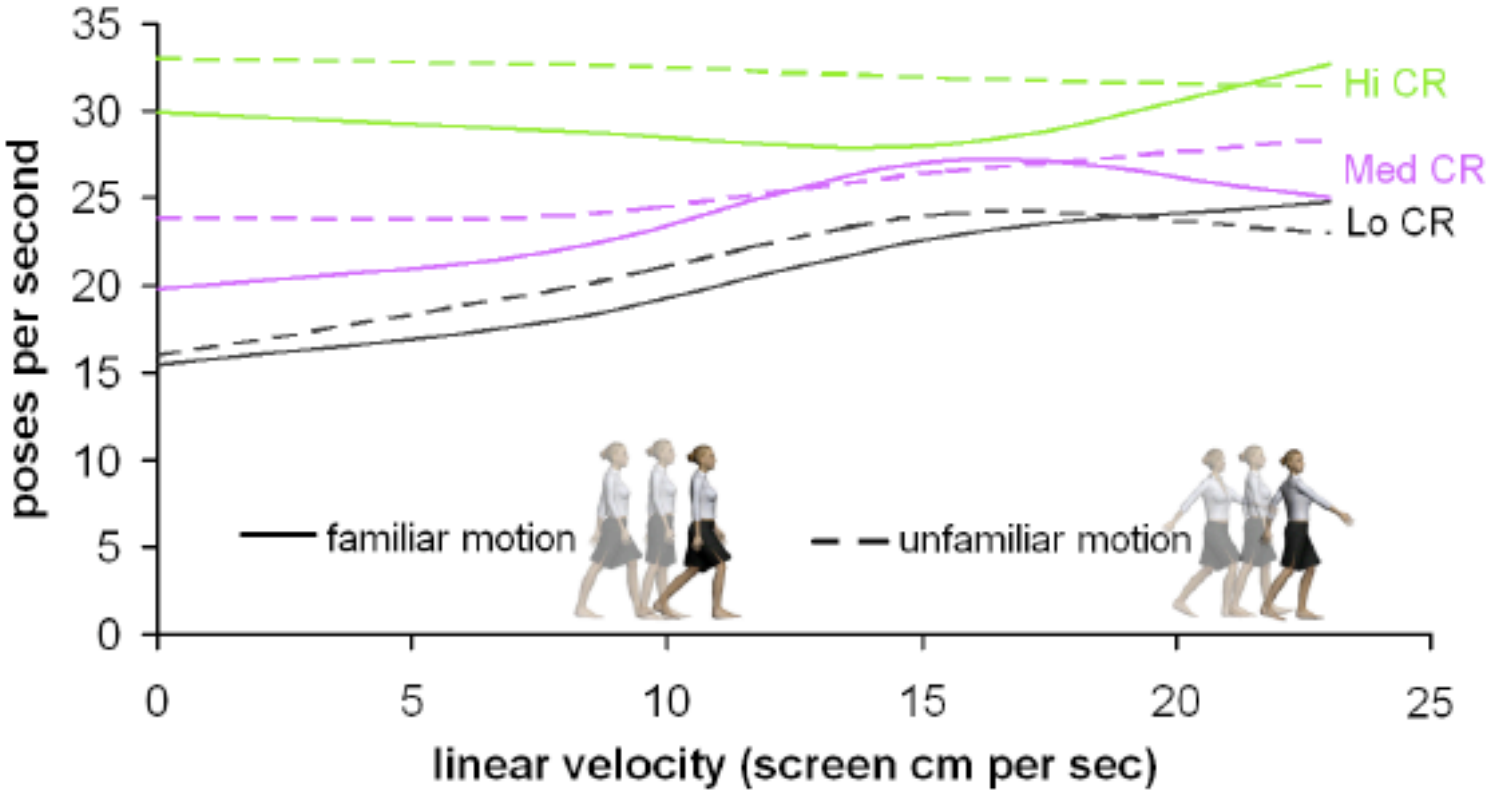
Results



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Example 3
Clone Attack

Clone Attack! Perception of Crowd Variety. Rachel McDonnell, Micheal Larkin, Simon Dobbyn, Steven Collins and Carol O'Sullivan. ACM SIGGRAPH 2008.

Clone Attack

- Question: how can we make a crowd using clones but without detecting the clones of appearance and the motion clones ?

Appearance Clones

Conclusions

- Appearance clones are easier to detect than motion clones
- Increasing clone multiplicity reduces variety significantly
- Color modulation and spatial separation effectively masks appearance clones

Conclusions (2)

- Combined appearance/motion clones are harder to find than static appareance clones only when their cloned motions are out-of-step
- Appearance clones are harder to find when combined with random motion
- Motion clones are not affected at all by appearance

Video

Example 4
Seing Is Believing

Seeing is Believing: Body Motion Dominates in Multisensory Conversations. Cathy Ennis, Rachel McDonnell and Carol O'Sullivan. ACM SIGGRAPH 2010.

Seeing is believing

- Question: is it important that the audio matches the body movements ?

Video

Example 5
Motion Blur

Presence of motion blur effect does not improve gaming experience. Lavanya Sharan, Zhe Han Neo, Kenny Mitchell and Jessica K. Hodgins. Motion in Games 2014.

Motion Blur Effect in Games

- Motion blur is used in video games to give a hint of speed

Split Second: Velocity [Black Rock Studios, Disney]

Motion Blur Effect in Games

- Motion blur is used in video games to give a hint of speed

- What is the practical impact of the motion blur effect on the player experience ?
- Is the value gained by including the effect worth the extra cost in computation, real-time performance, development time, etc… ?

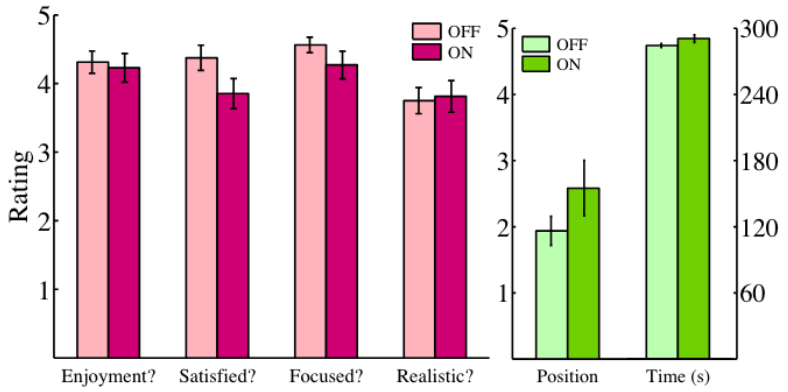
Motion Blur Effect in Games

- 5 experiments
  - Objective measures of performance (time taken to perform a race)
  - Subjective measures of gaming experience (satisfaction with the performance)
- Independent variable: motion blur ON or OFF
- Independent variable: straight line acceleration of the racing car LOW or HIGH

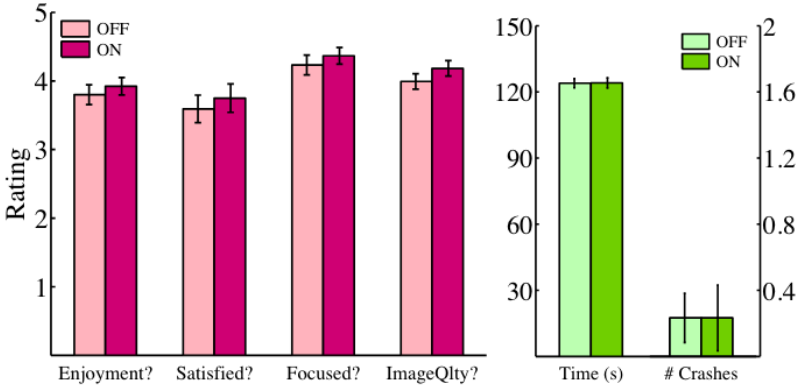
Motion Blur Effect in Games

	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5
Independent variable	Motion blur	Motion blur	Motion blur	Acceleration	Motion blur
# Participants	8	15	11	11	23
# Races per participant	4	8	12	12	12
# Laps per race	3	3	3	3	3
Track	Airport	Storm Drain	Storm Drain	Storm Drain	Storm Drain
Competitive	✓	✗	✗	✗	✗
Power plays	✓	✗	✗	✗	✗
Straight-line acceleration	0.5	0.09	0.09	0.09, 0.5	0.5
Motion blur setting	Off, Default	Off, Default	Off, Default	Off	Off, Default
Post-race question about enjoyment of race	✓	✓	✓	✗	✓
Post-race question about satisfaction with performance	✓	✓	✓	✗	✓
Post-race question about focus during race	✓	✓	✓	✗	✓
Post-race question about motion blur	Realism	Image Quality	Blurriness	Blurriness	Blurriness
Post-race questions about perceived speed	✗	✓	✓	✓	✓
Post-race question about ease of handling	✗	✗	✗	✓	✓
Post-experiment question about blur consistency	✗	✗	✓	✓	✓
Per-race position (e.g., 1^{st}, 2^{nd})	✓	✗	✗	✗	✗
Per-race highest speed	✓	✓	✓	✓	✓
Per-race completion time	✓	✓	✓	✓	✓
Per-race number of crashes	✗	✓	✓	✓	✓
Per-race number of scrapes	✗	✗	✗	✓	✓

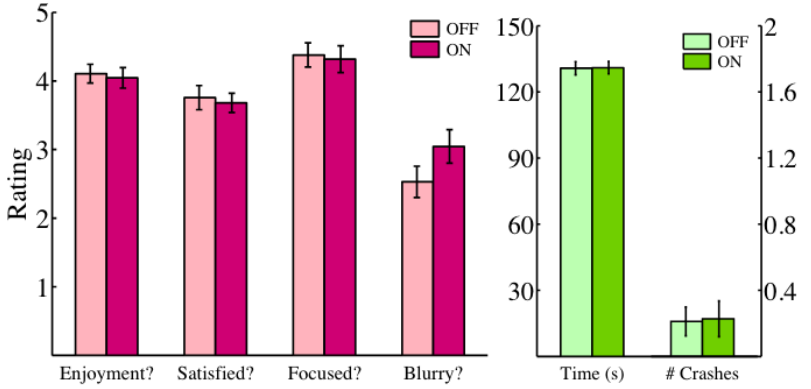
(a) *Airport track*



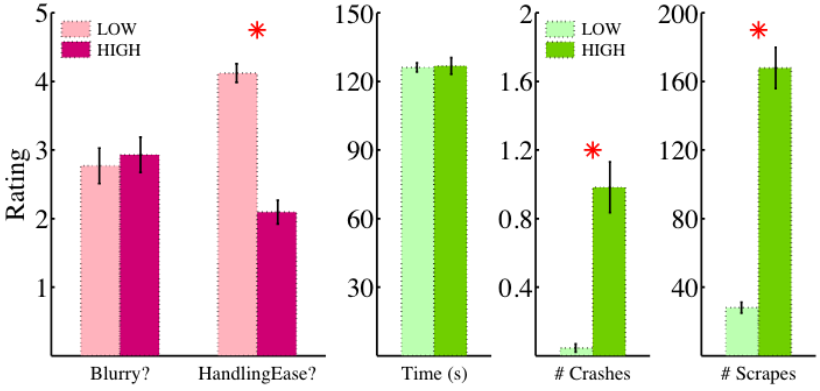
(b) *Exp 1* ($n = 8$)



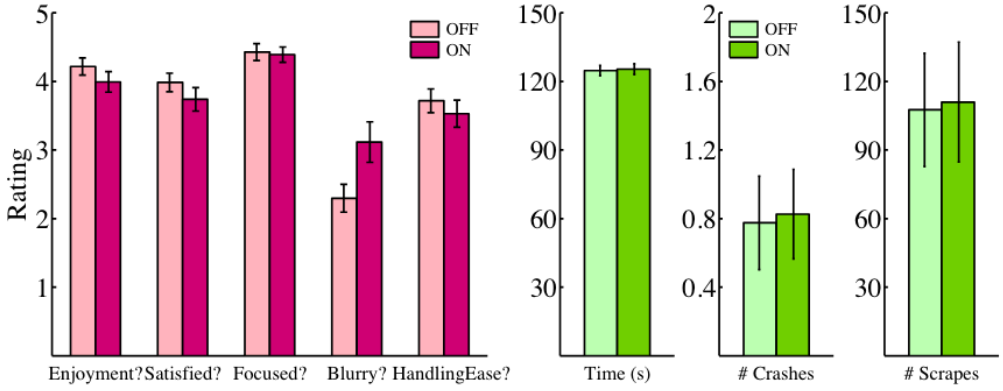
(c) *Exp 2* ($n = 15$)



(d) *Exp 3* ($n = 11$)



(e) *Exp 4* ($n = 11$)



(f) *Exp 5* ($n = 23$)

Motion Blur Effect in Games

Results :

- **Presence of motion blur effect does not significantly enhance player experience**

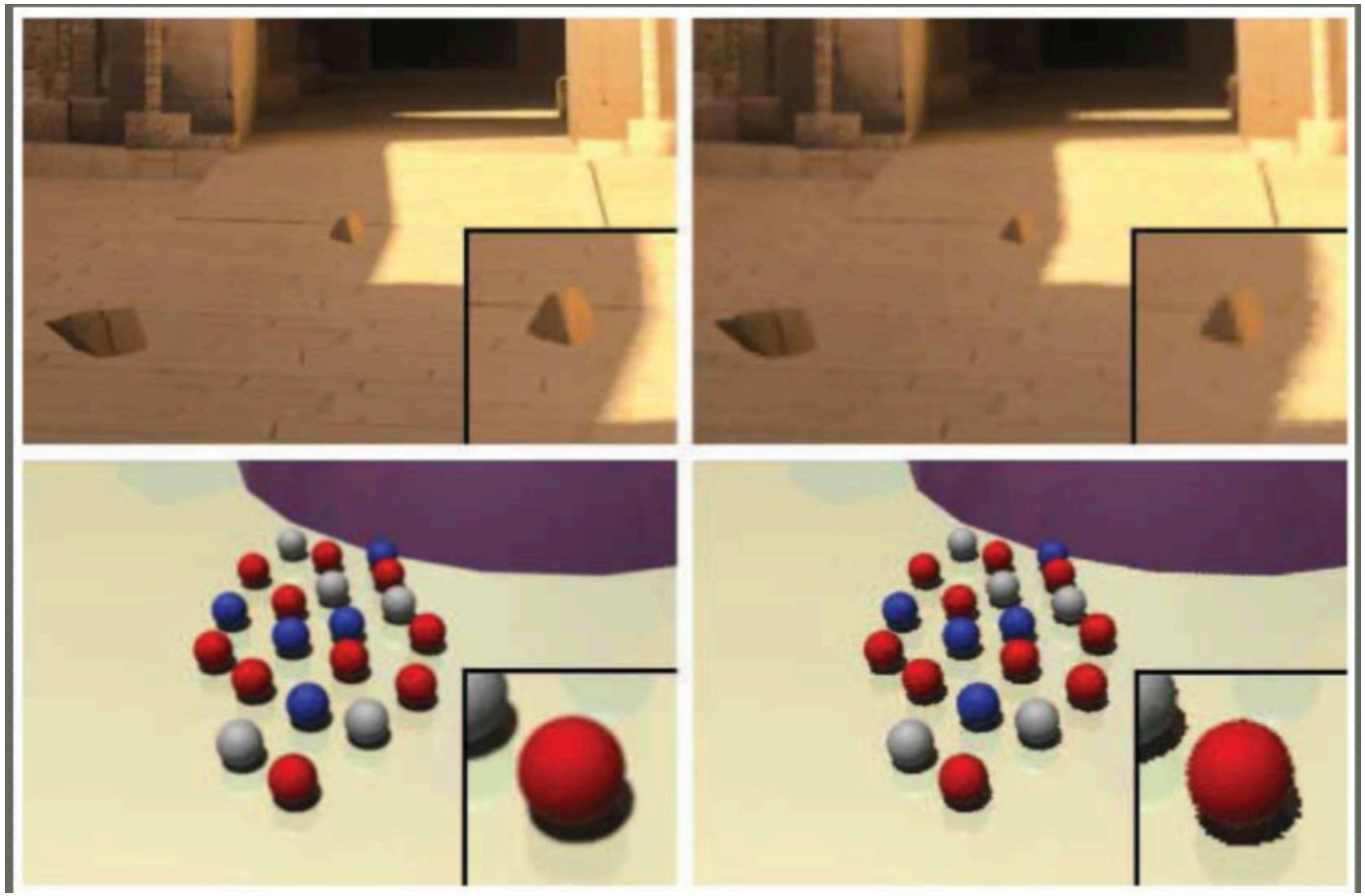
Example 6
Task Based Simplification

Parallel selective rendering of high-fidelity virtual environments. K. Debattista, A. Chalmers, R. Gillibrand, P. Longhurst, G. Mastoropoulou, V. Sundstedt. Parallel Computing 2007.

Task Based Simplification

- Used to speed-up rendering
  - Study where people tend to look in a scene
    - Saliency of objects / colors
    - Fovea and screen center
- Give a task to people (count the vases)
- Lower the rendering quality where people do not look

Task Based Simplification



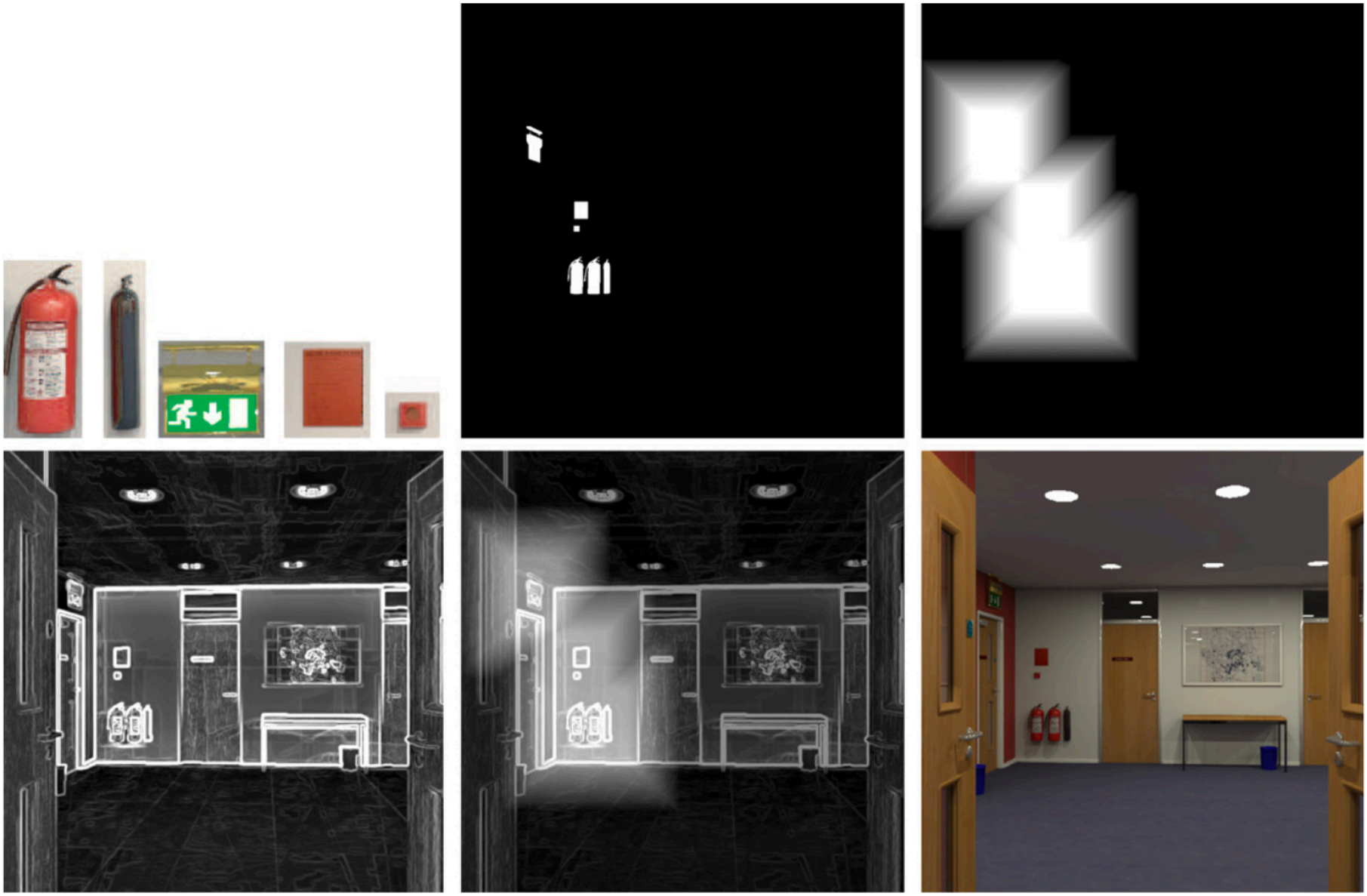


Fig. 3. The Corridor scene. Top row, from left to right: the fire safety objects identified as tasks, the task map, the task map with foveal angle gradient applied. Bottom row, from left to right: the saliency map, the importance map of IM(0.5, 0.5, +) and the final rendered image.