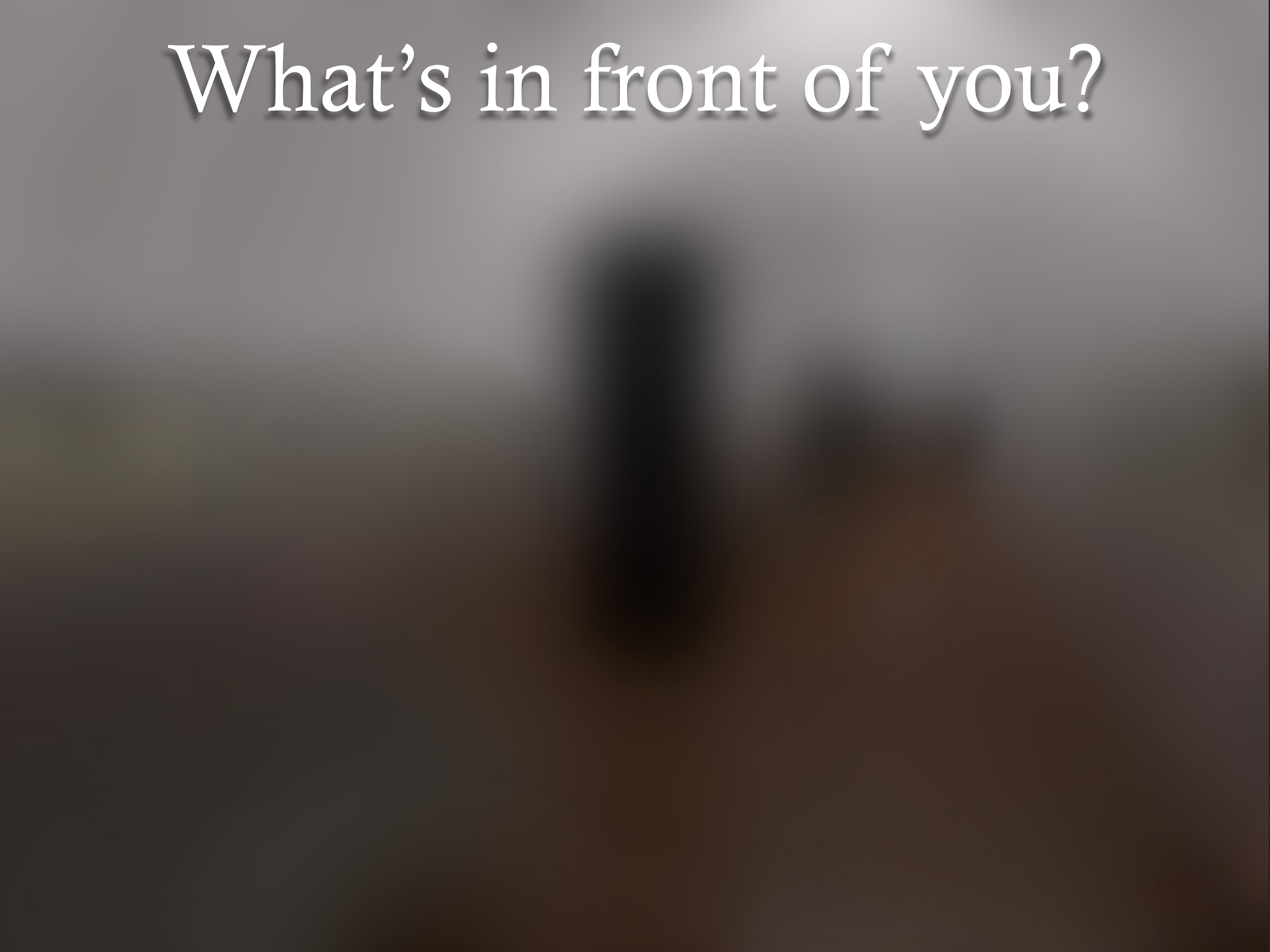
DEVA UPDATE

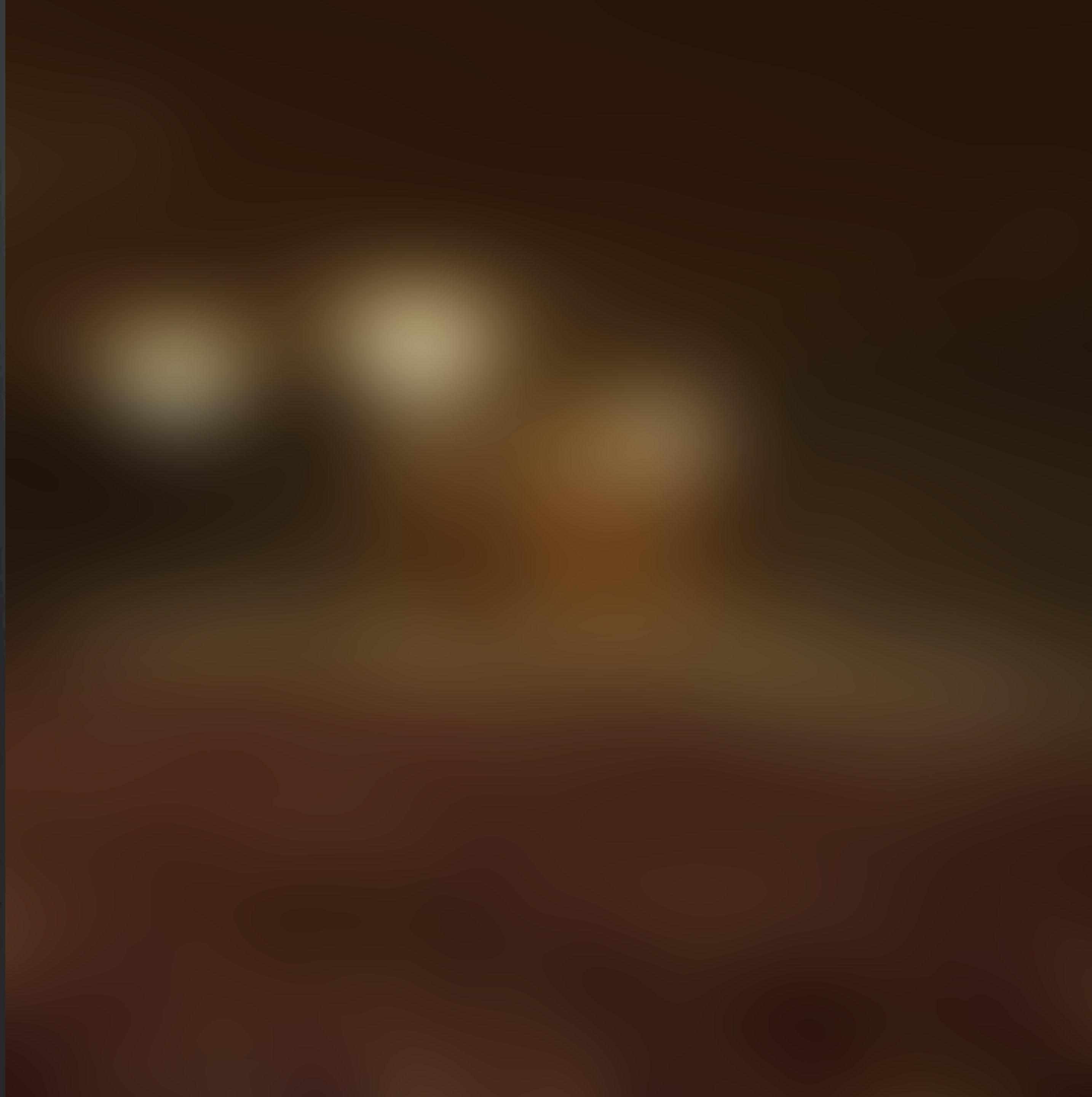
Rob Shakespeare
Indiana University

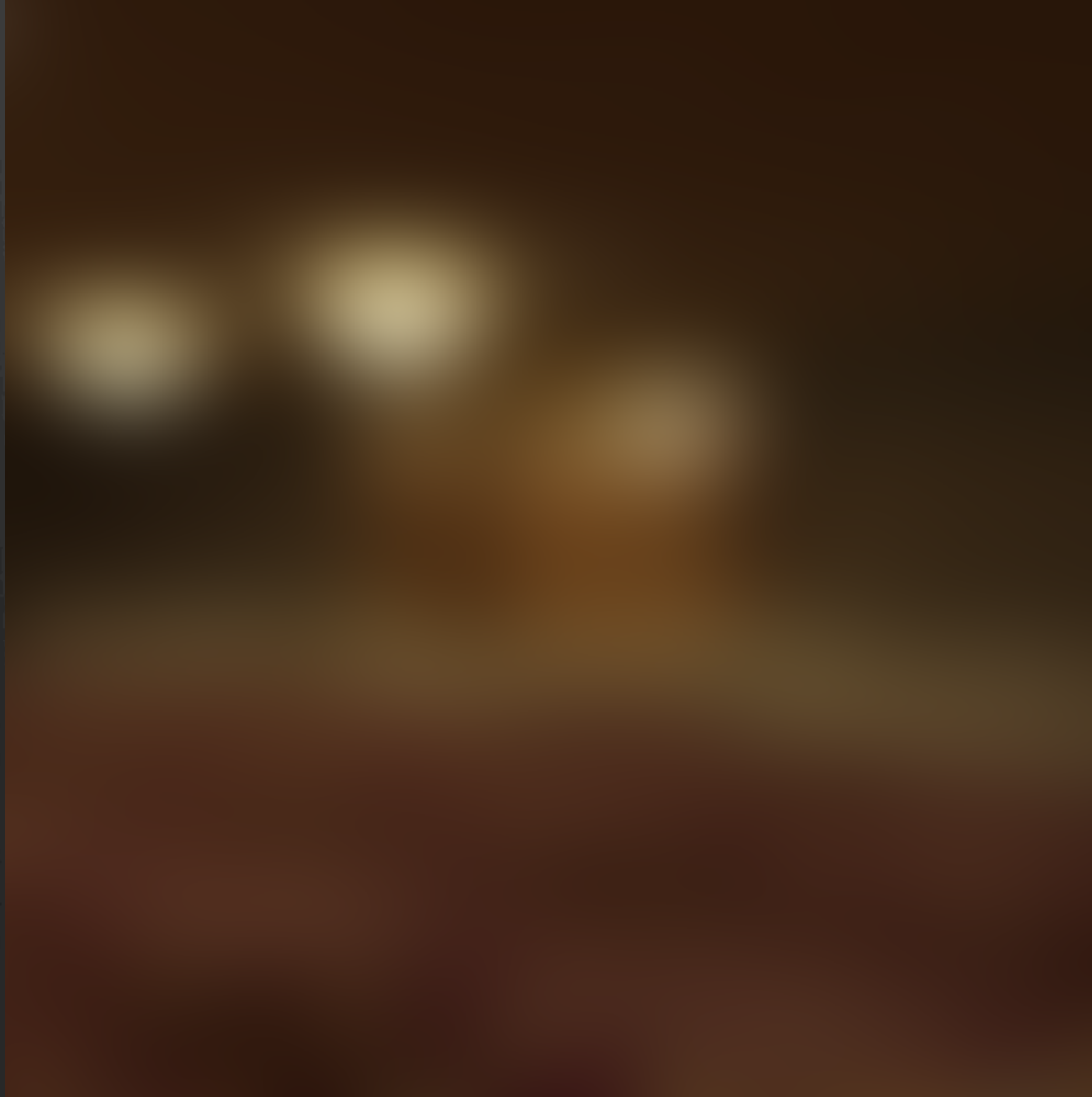
Designing Visually Accessible Spaces
NIH Grant 1 R01 EY017835-01

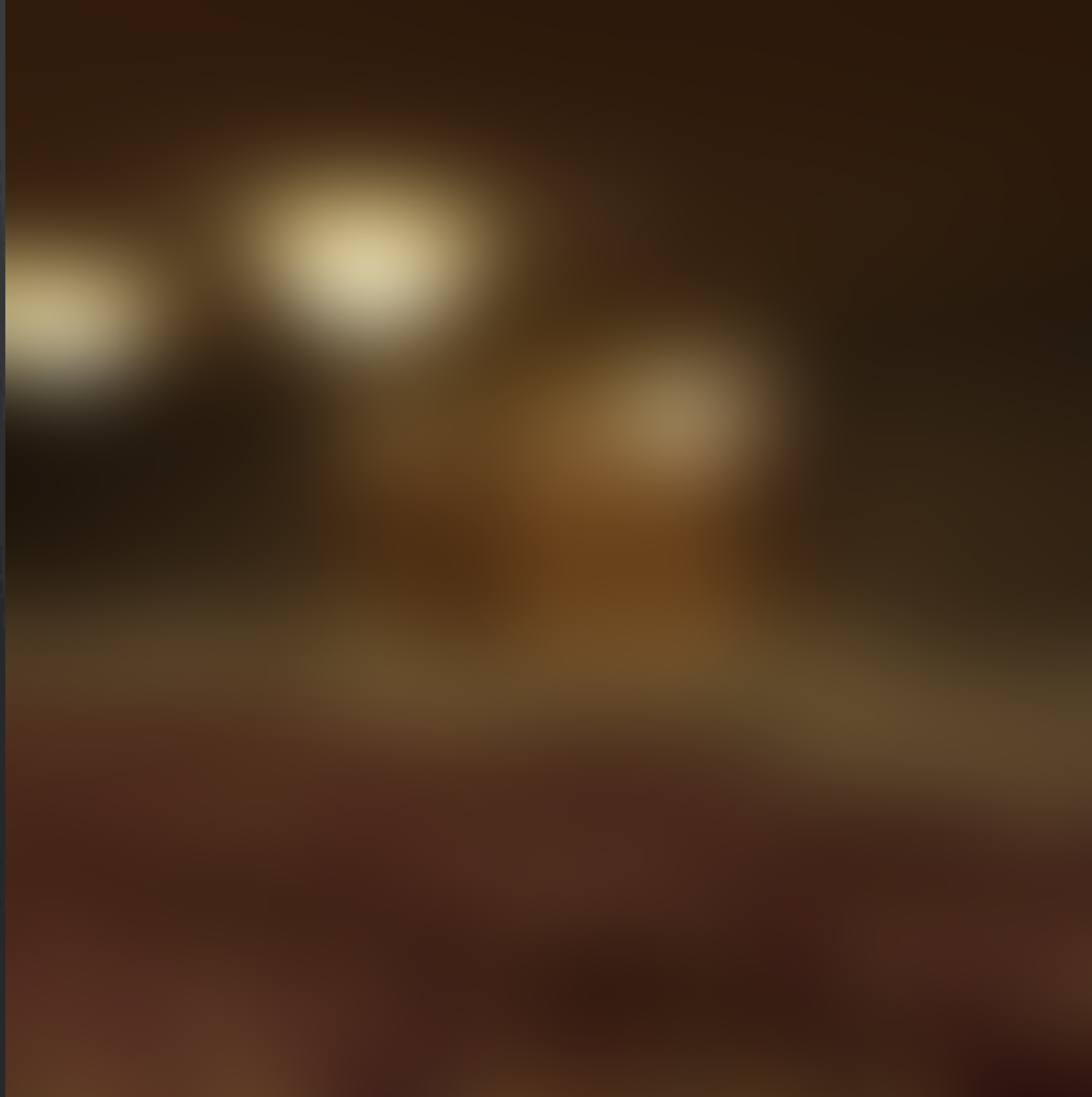
Radiance International Workshop 2011, August 24-26
Lawrence Berkeley National Laboratories, U.C Berkeley

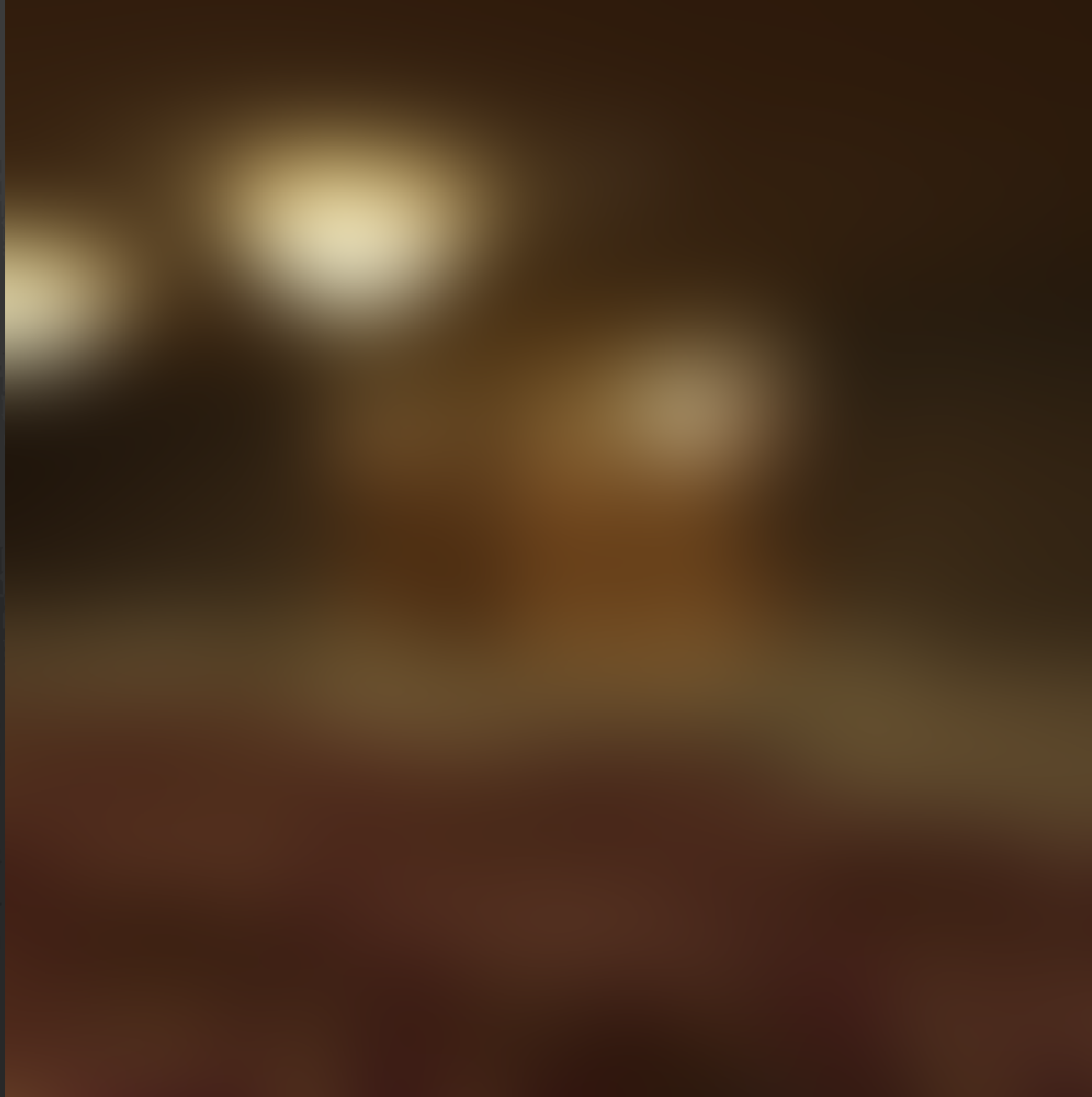

What's in front of you?

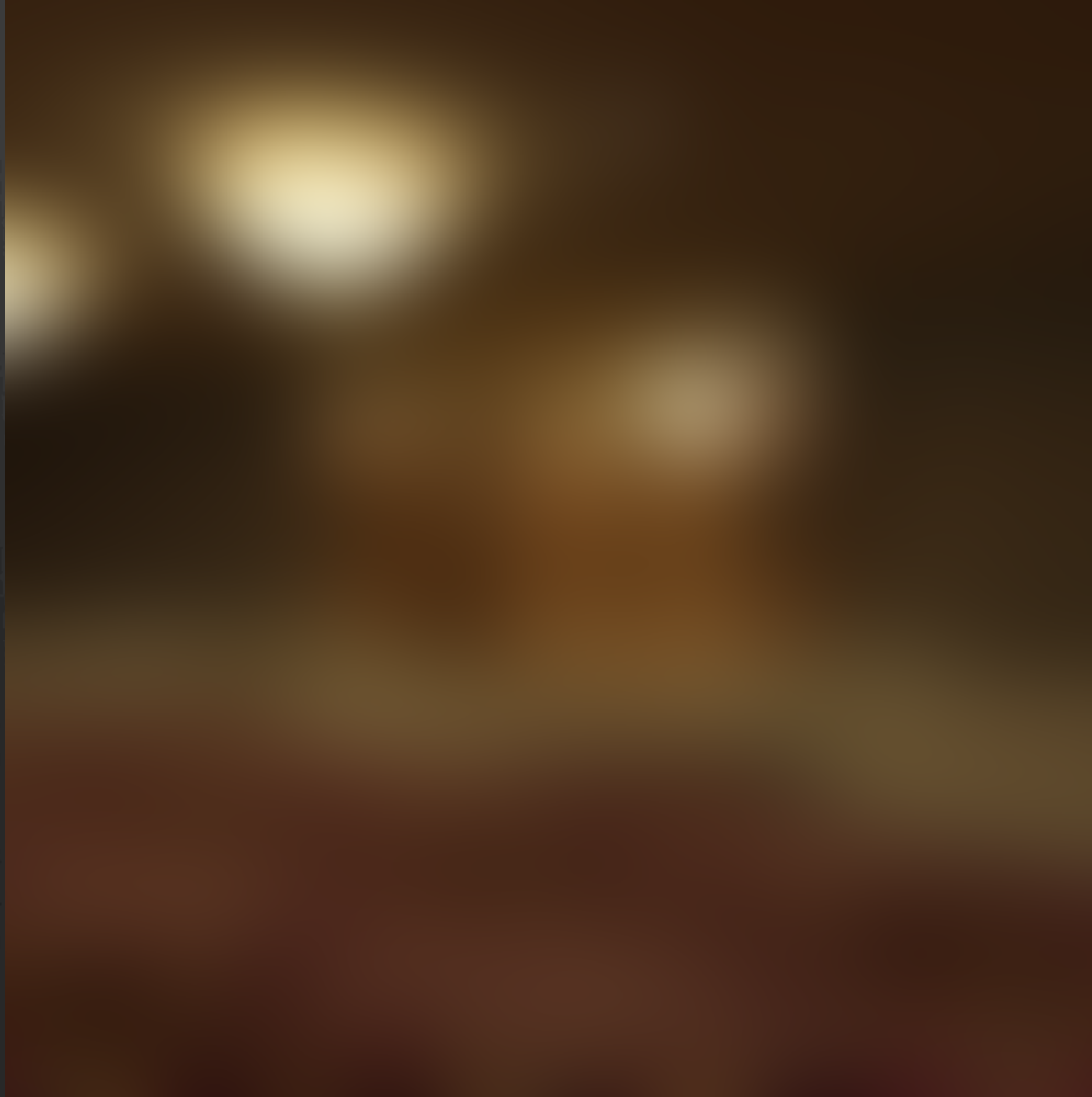
Here is a different scene,
Let’s take a walk…

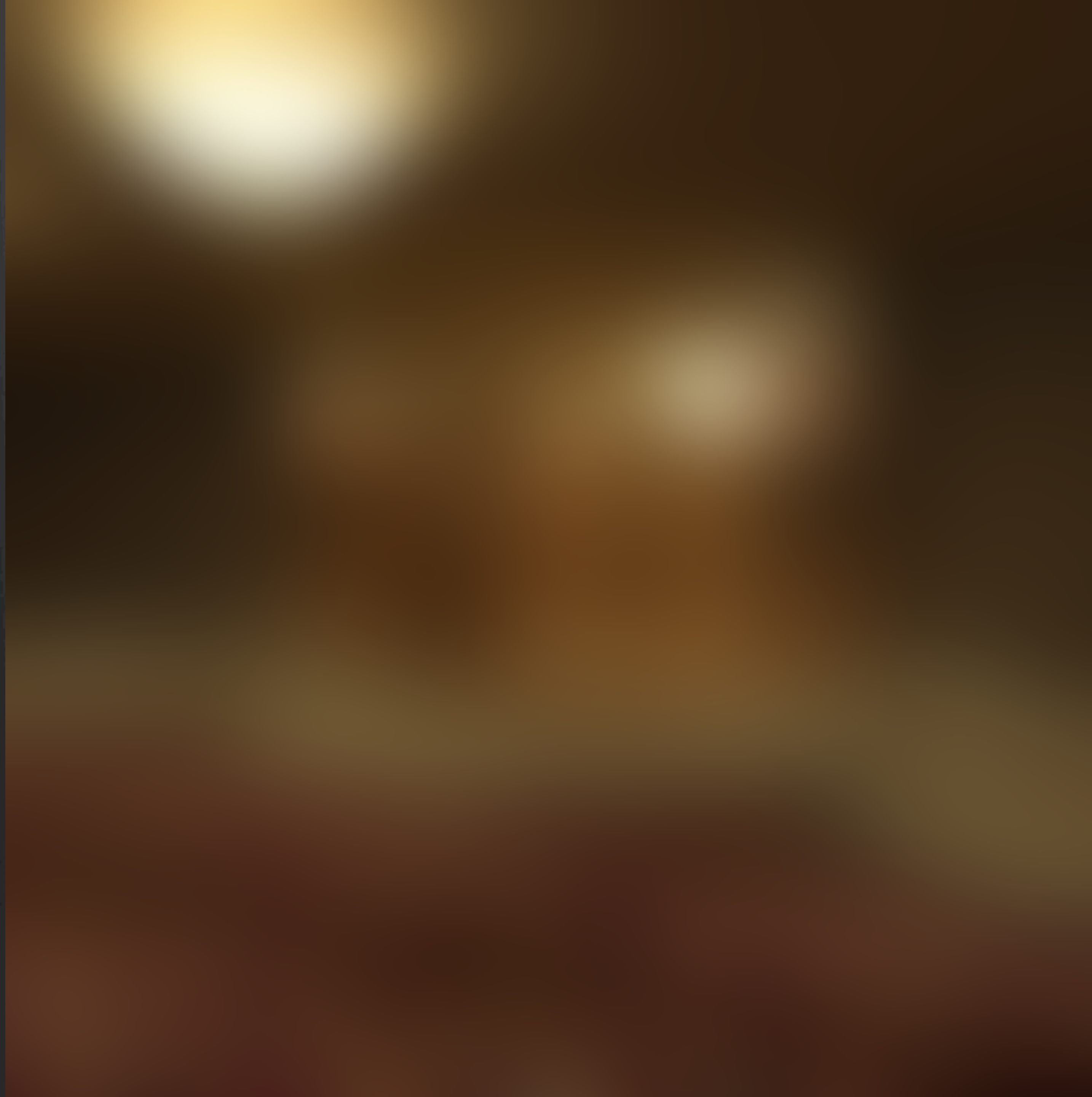


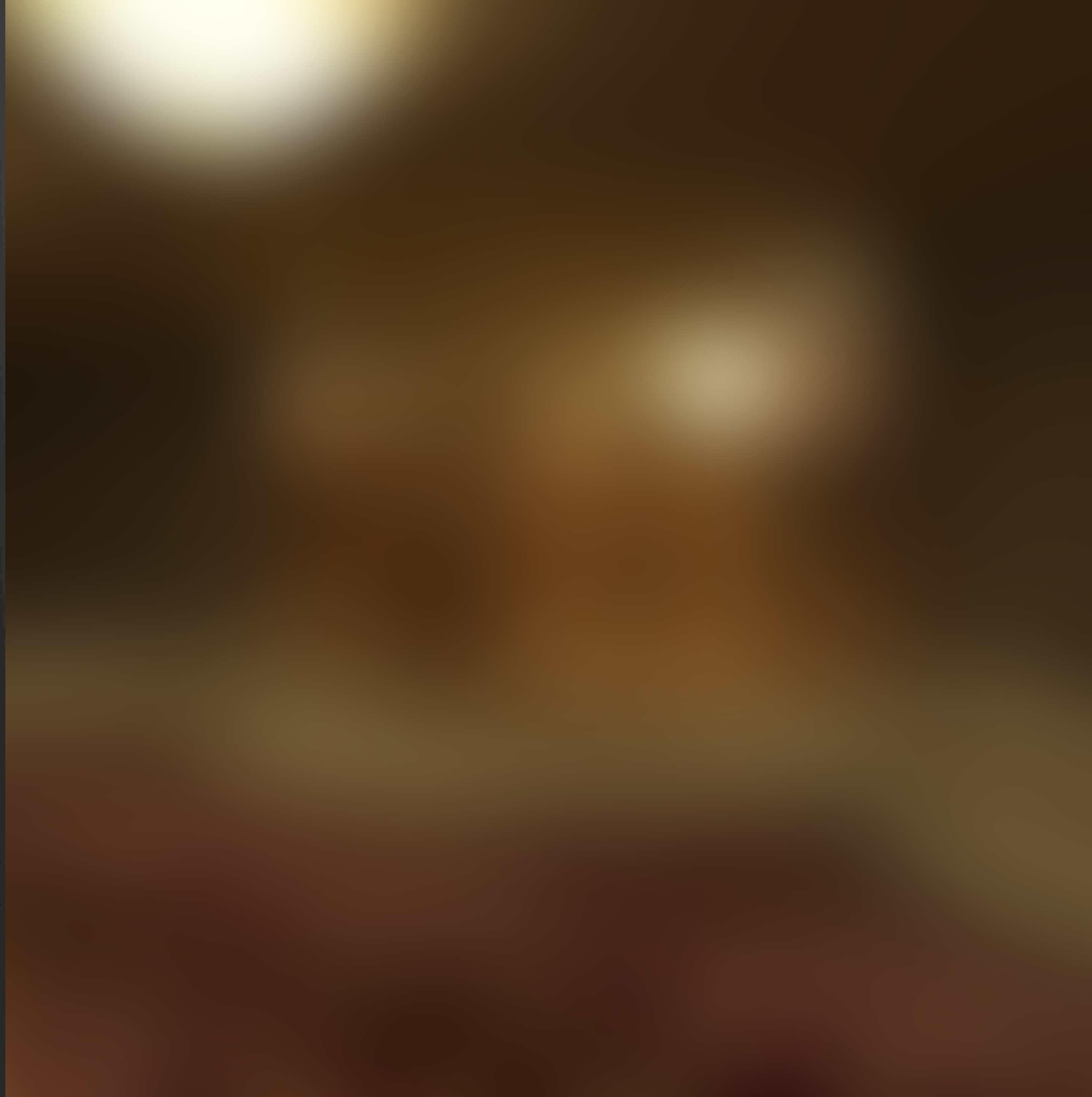


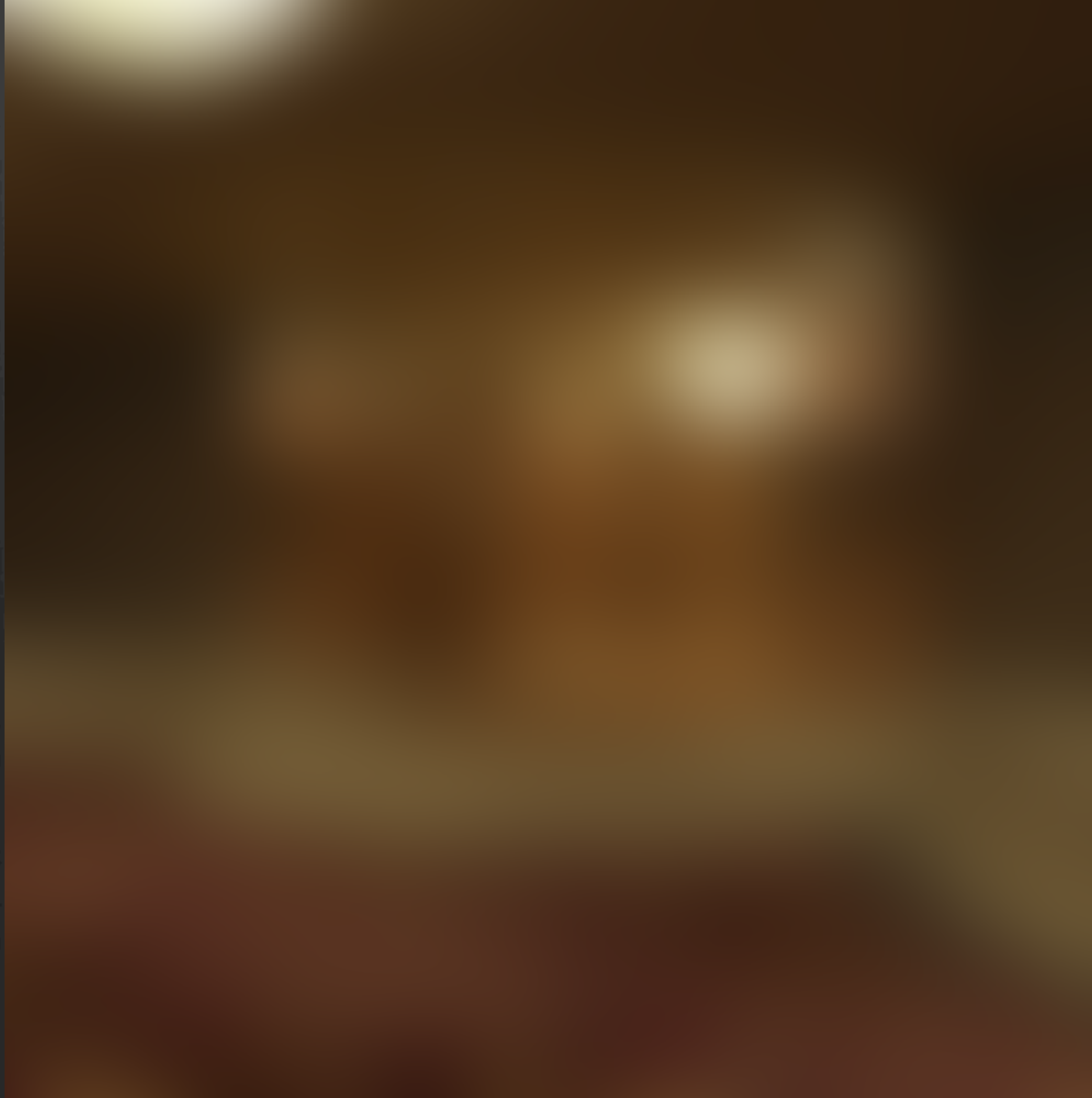


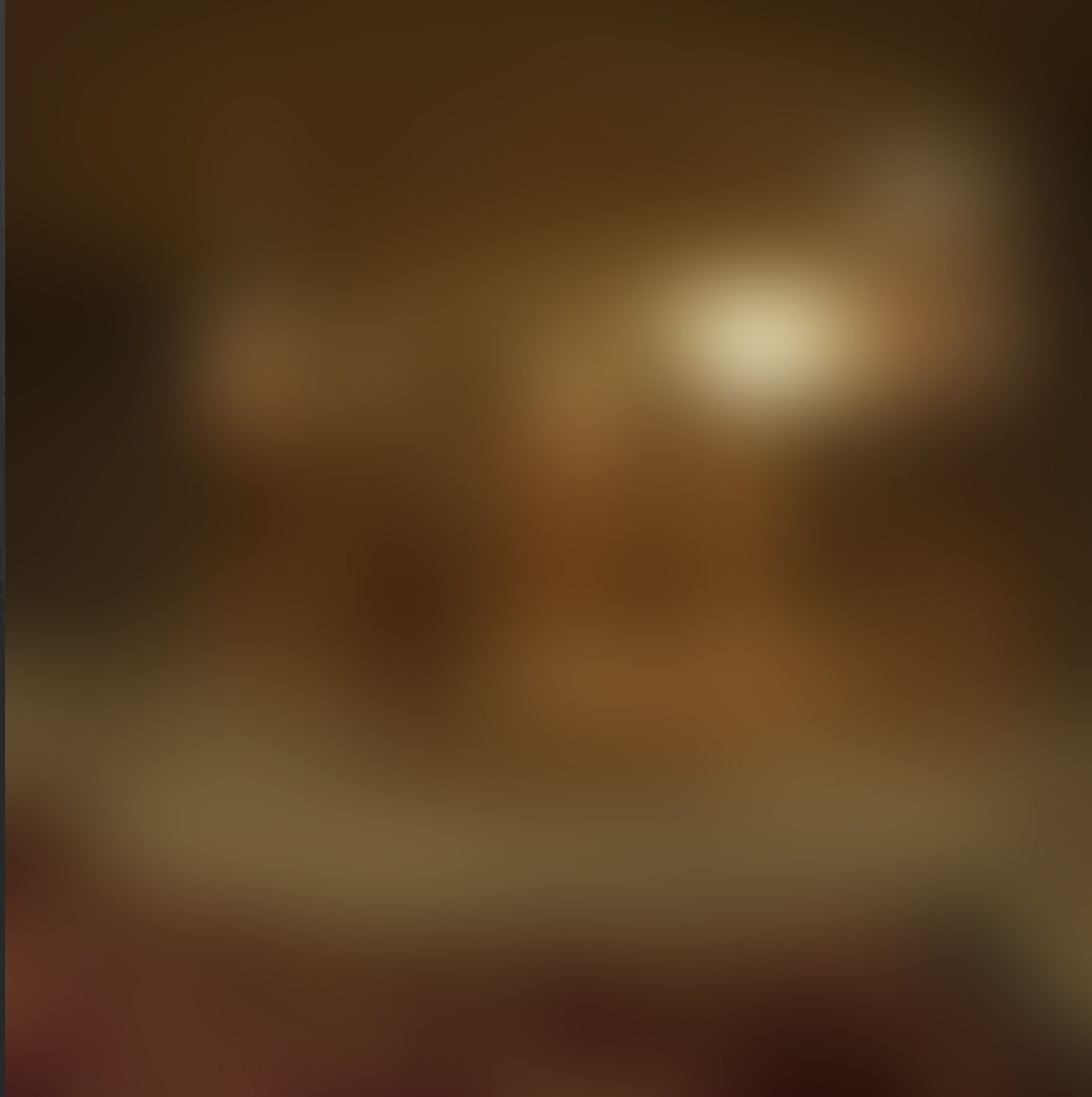


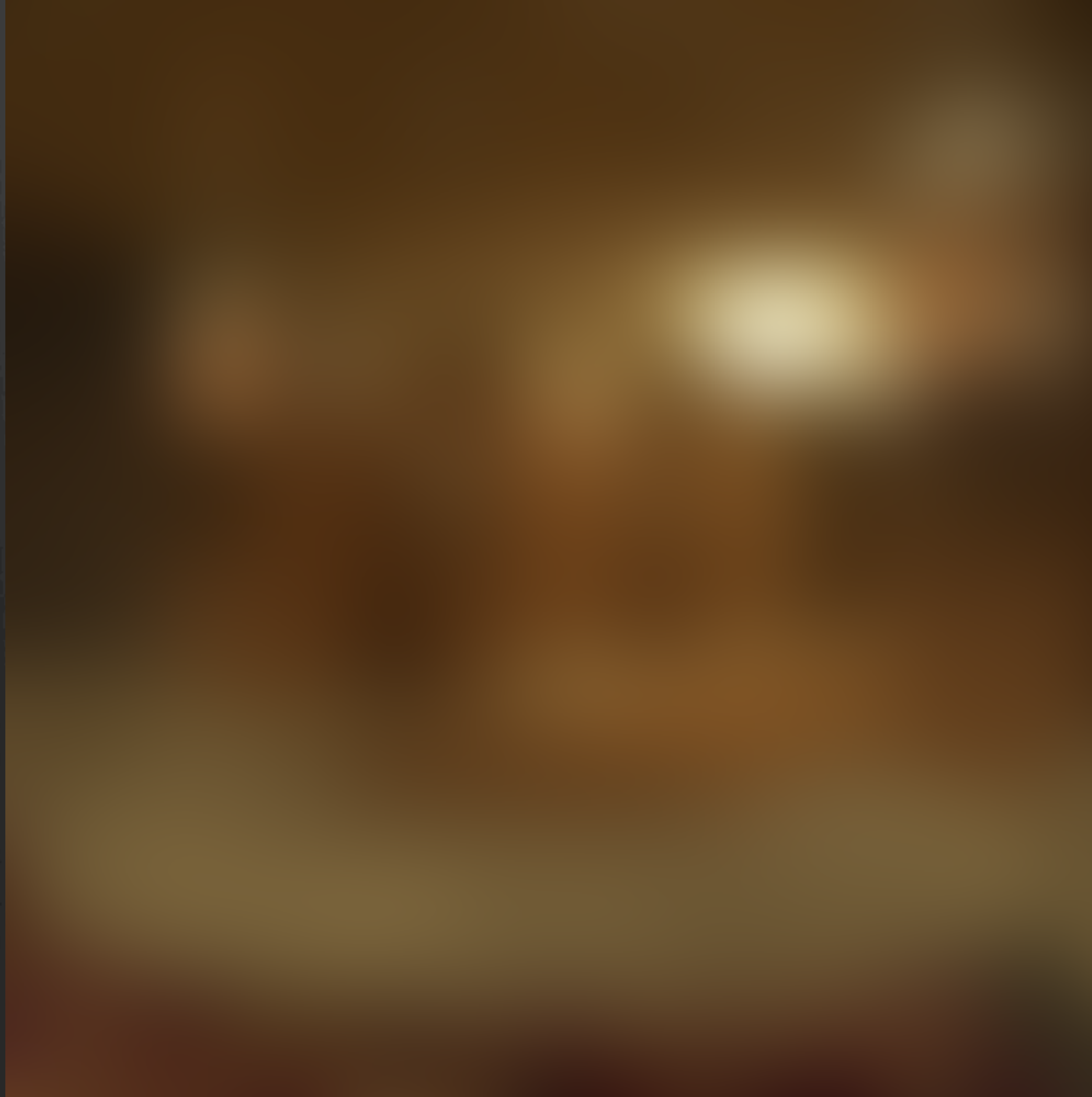


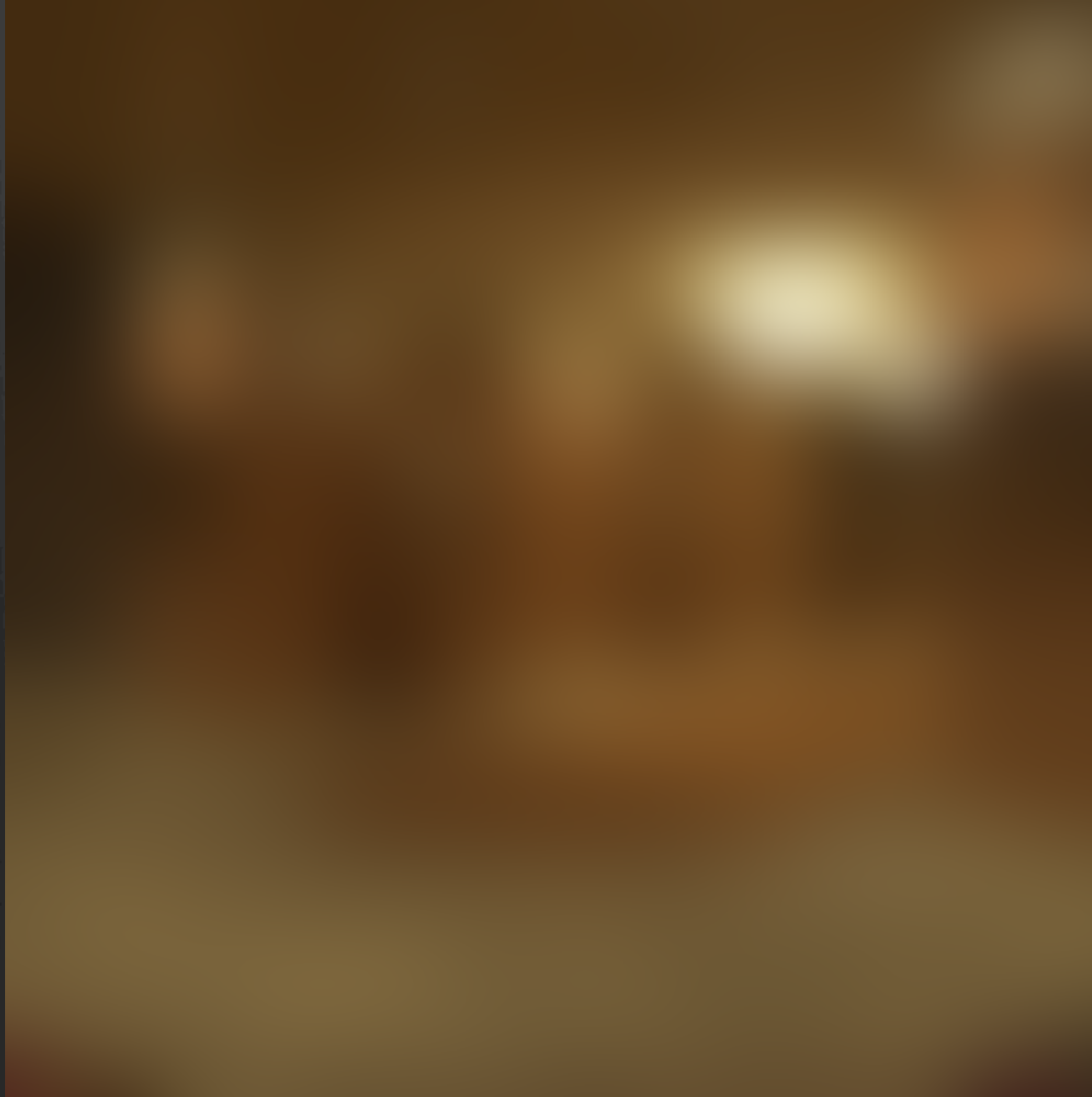












Ouch!!

Snap !!!!!

Ouch!!

Groan !!!!!

very high risk at ~20/1000

Ouch!!

Groan !!!!!

!! SUE !!!!

New subject with ~20/600 acuity, new path…

Ouch!!

Groan !!!!!

Ouch!!

Groan !!!!!

!! SNAP !!!!

very high risk at ~20/600

Ouch!!

Groan !!!!!

!! SUE !!!!

Same acuity with Lighting Adjustment


AH! A Step!!

AH! A Step!!
It's not flat!

Modest risk at ~20/600

Material Adjustment

Increases step contrast

Low risk rating at ~20/600

Visual Accessibility Improved

Low risk rating at ~20/600

Visually Accessible?

20/20 acuity

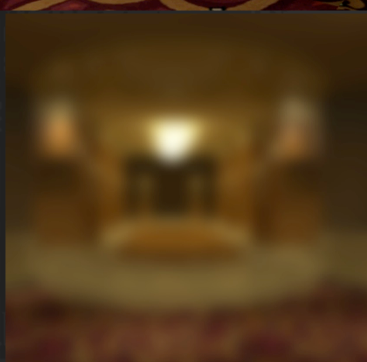
Visual Accessibility Improved

20/20 acuity

Visual Accessibility Optimized

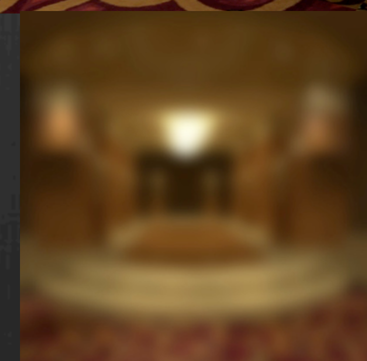
20/20 acuity

Visual Accessibility Evaluations
(exploratory scenarios, risk factors estimated for illustration)



Very high risk at ~20/600

Low risk at ~20/600



Modest risk at ~20/600

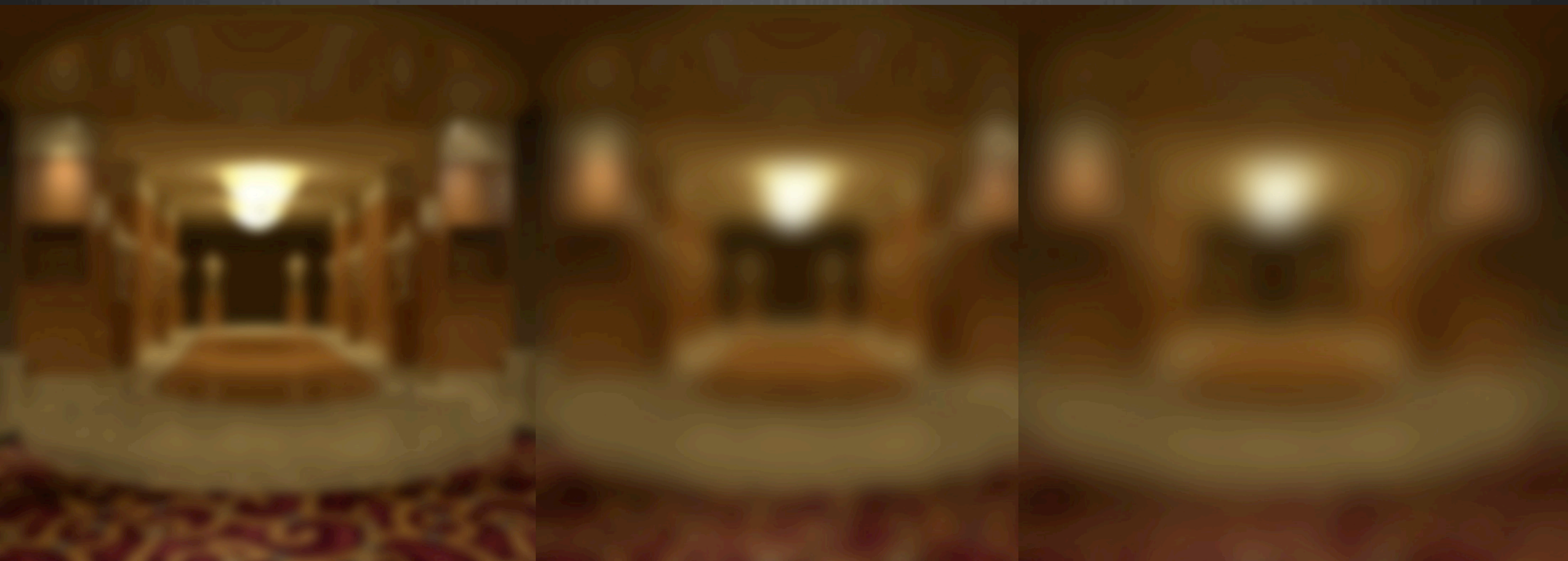
DEVA aims to develop tools to:

Identify regions with potential visual hazards

Provide designers with feedback to assist in reducing visual hazard risk

Increase Visual Accessibility

Interactive tool 1:



A range of acuities aids designer in determining areas of challenge and in working through iterative fixes.

Designer determines success.

Interactive tool 2:

IF a Radiance data set, diagnostics available to designer, in this case geometric change without luminance change is highlighted.

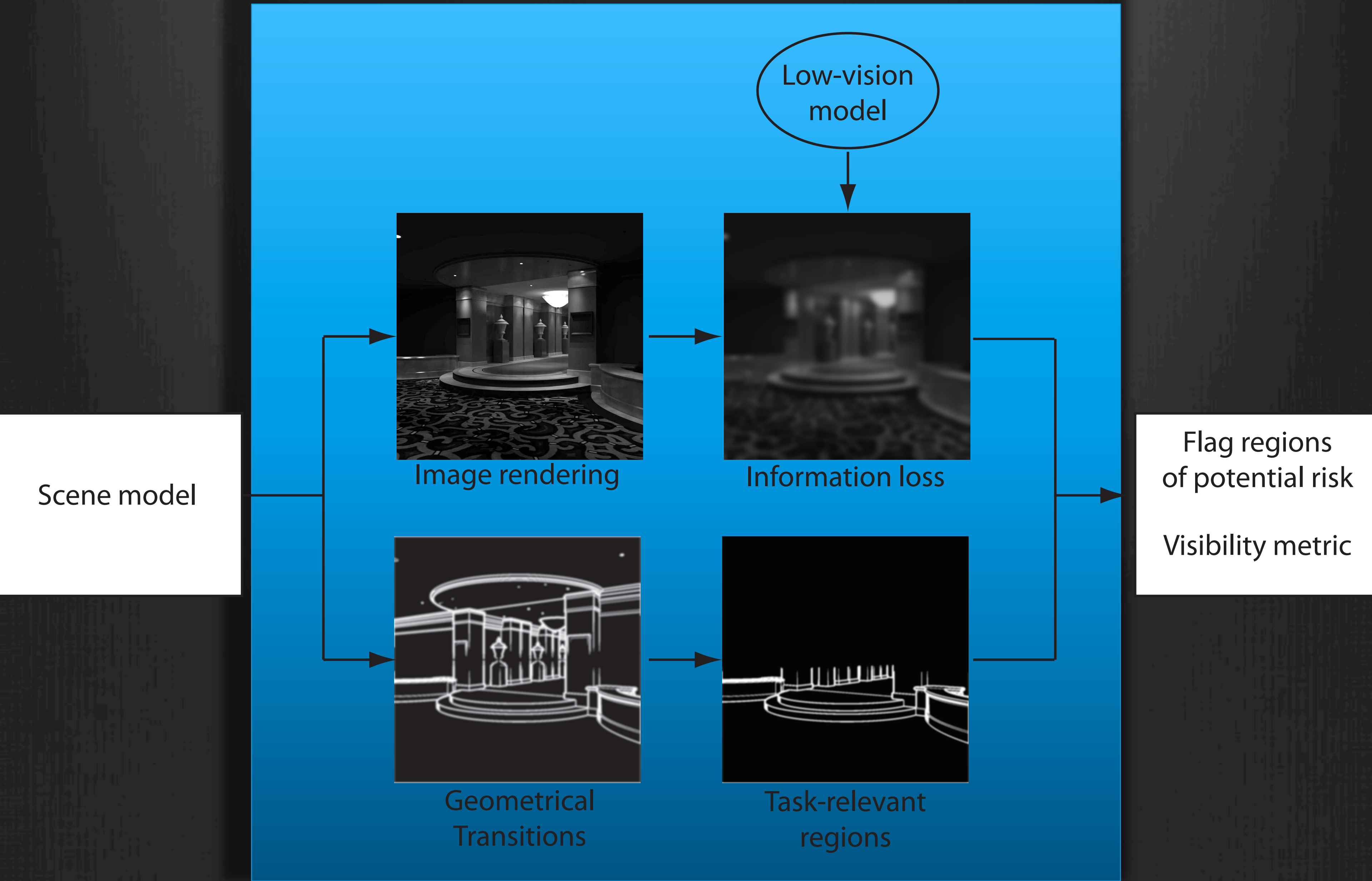
Designer determines success.

Automated tool: Important rationale

Difficult for someone with normal vision,
who has observed the scene previously (at 20/20)
to appreciate how difficult it is
to interpret a blurry scene that has not been seen before
(low-vision person entering a space for the first time).

If we've seen the full-resolution scene
before viewing the blurry one, our visual system
automatically applies our memories
to improve the interpretation of the blurry scene.

Automated tool workflow

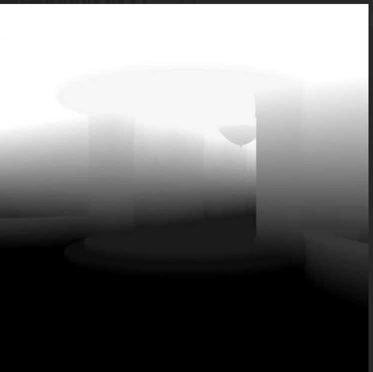


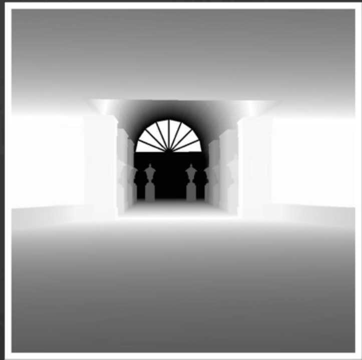
Geometric transitions generate:

Ground Truth (independent of luminance)

Normals to determine geometrical changes

```
## create normal at surface text file
        set  norflnm = $bfnm"nor"$t
        vwrays -fd $dirhdrfnm | rtrace -fda `vwrays -d $dirhdrfnm` -oN $octree >  $subd/$norflnm &
```





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## create normal at surface text file
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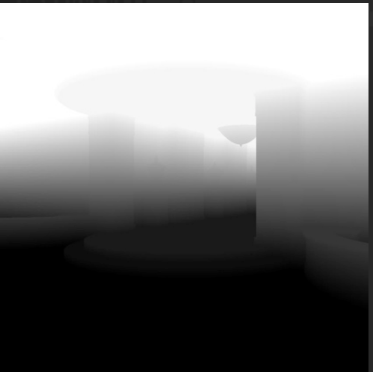
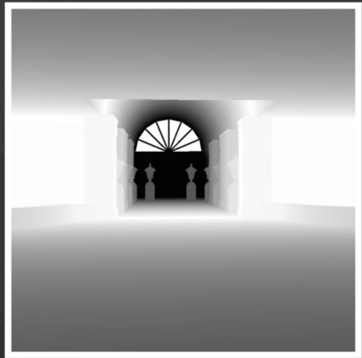
```

Range data to extract task relevant regions

```
## create 3d coordinate text file
        set  xyzflnm = $bfnm"xyz"$t
        vwrays -fd $dirhdrfnm | rtrace -fda `vwrays -d $dirhdrfnm` -op $octree >  $subd/$xyzflnm &

## create distance to surface text file
        set  dstflnm = $bfnm"dst"$t
        vwrays -fd $dirhdrfnm | rtrace -fda `vwrays -d $dirhdrfnm` -os $octree >  $subd/$dstflnm &
```






Task relevant regions:

User defines height above/below "floor"

Tool finds potential hazard within N radius or user selected

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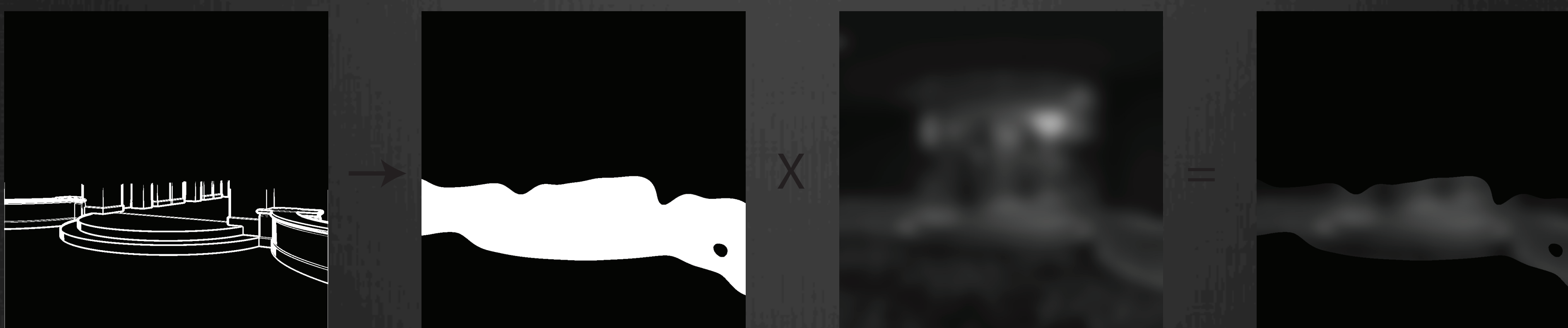
User defines height above/below "floor"

Tool finds potential hazard within N radius or user selected

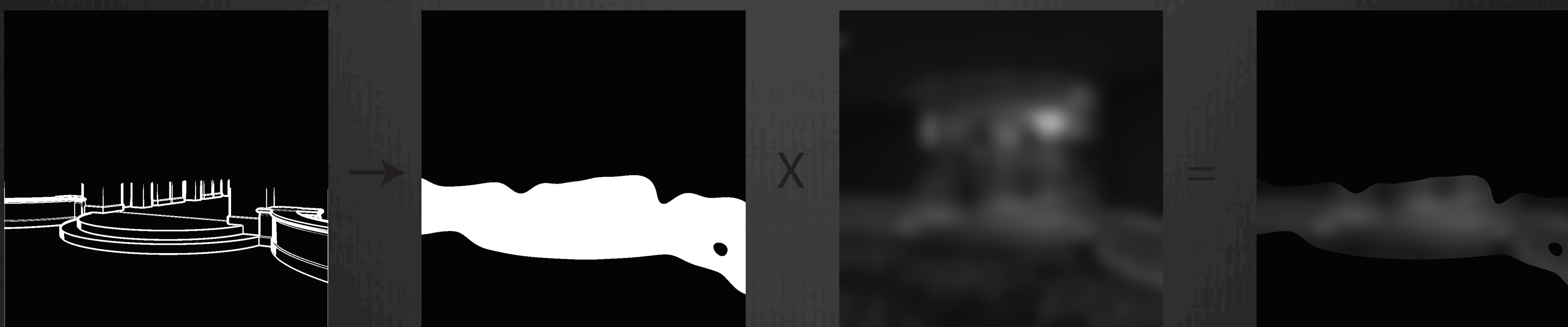
Zone is dilated to create mask then combined with Peli* filtered low acuity image(s)



*Low vision simulation filter, Eli Peli, Professor of Ophthalmology, Harvard Medical School

Zone evaluated by comparing discontinuities between luminance patterns and ground truth surfaces in original and blurred images, in addition to other metrics resulting in a visual risk/visibility score…

…Independent of designer



(Note: Peli filter is responsive to visual luminous threshold and glare factors.)

Analysis delivered to designer..

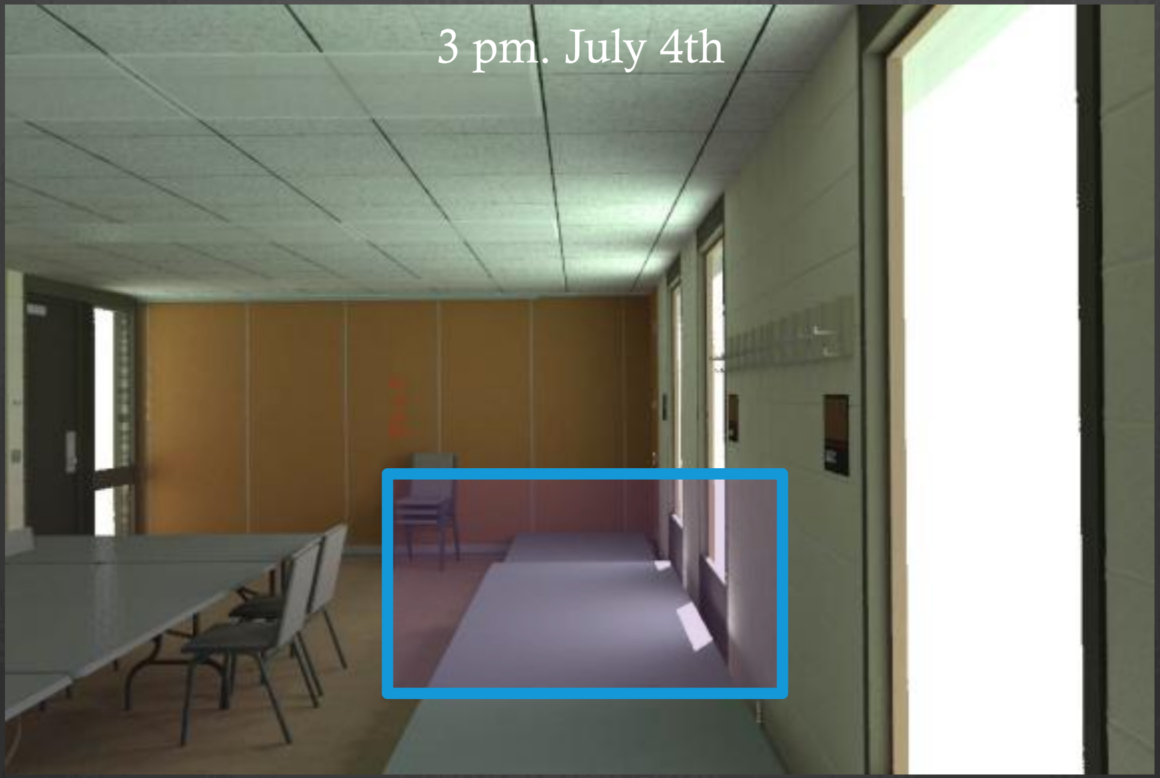
High risk
Low visibility

Low risk

Exploring VISIBILITY METRICS

- A low value of geometry-based metric predicts low visibility
  - This is when locations of large intensity changes don’t match the locations of the depth/slope changes

Exploring VISIBILITY METRICS



- Region is selected, ready for automated analysis
- Various visibility indicators generated per picture

Day Sequence Analysis

- [illegible]
- [illegible]
- [illegible]

- [illegible] hrs

Exploring VISIBILITY METRICS

- Predicted hours of highest and lowest step visibility:
  - Normal acuity and contrast

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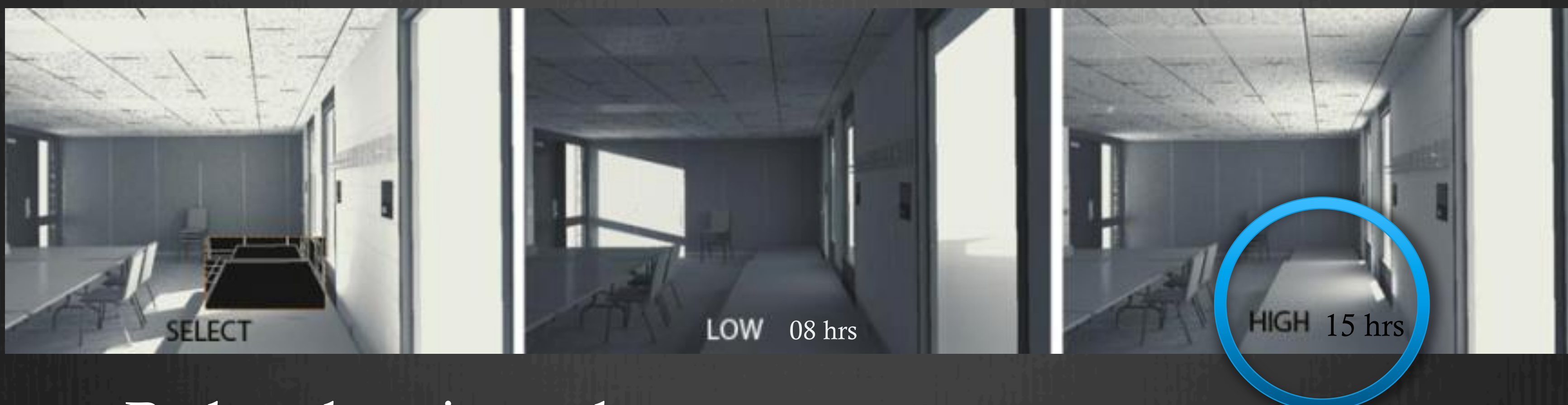
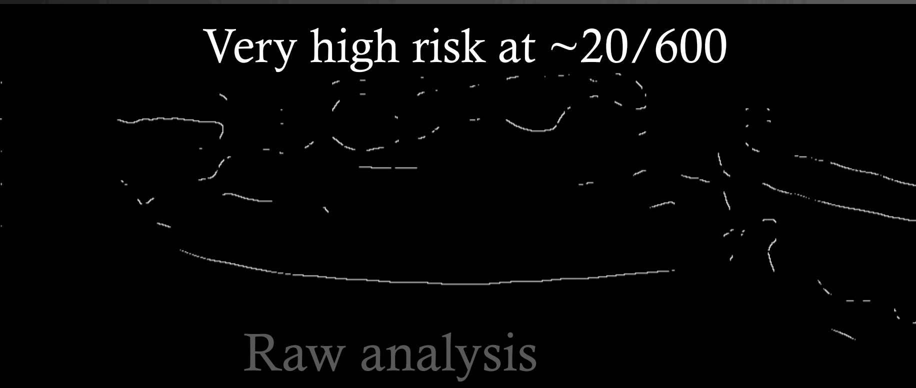
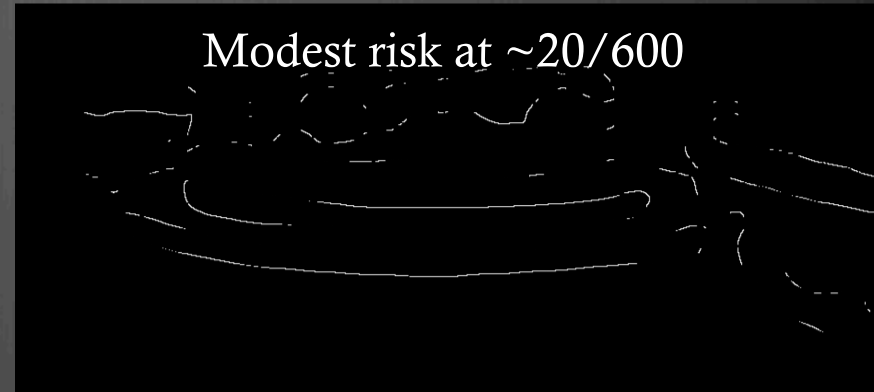


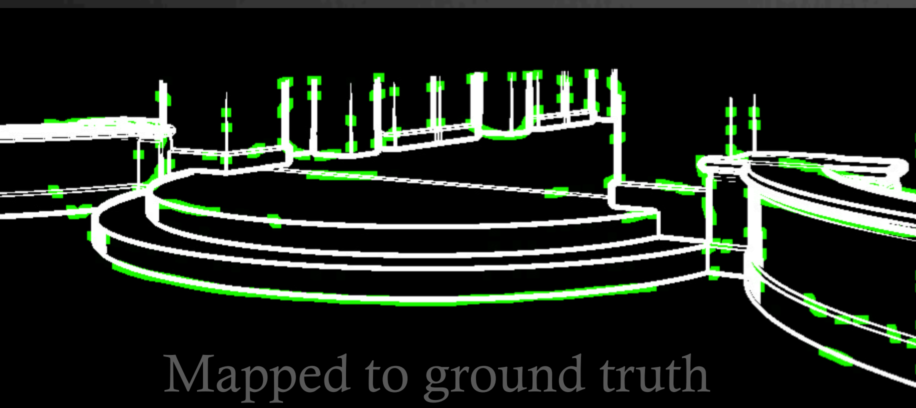
  - Reduced acuity and contrast:

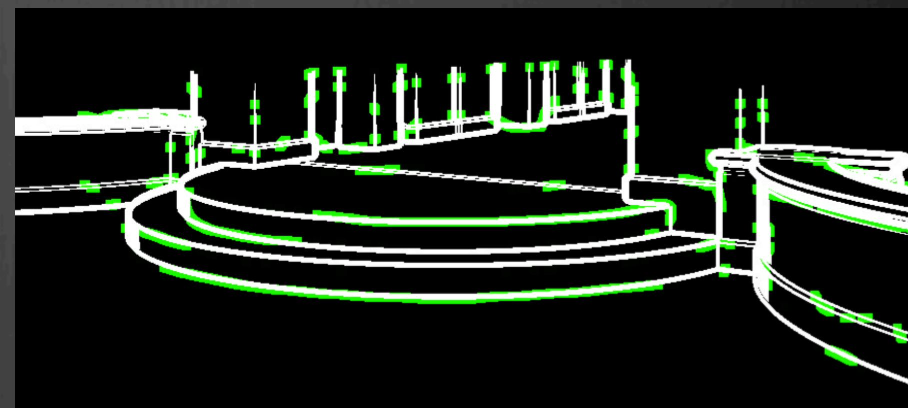
Higher Risk Lower Risk

Other VISIBILITY METRICS explorations







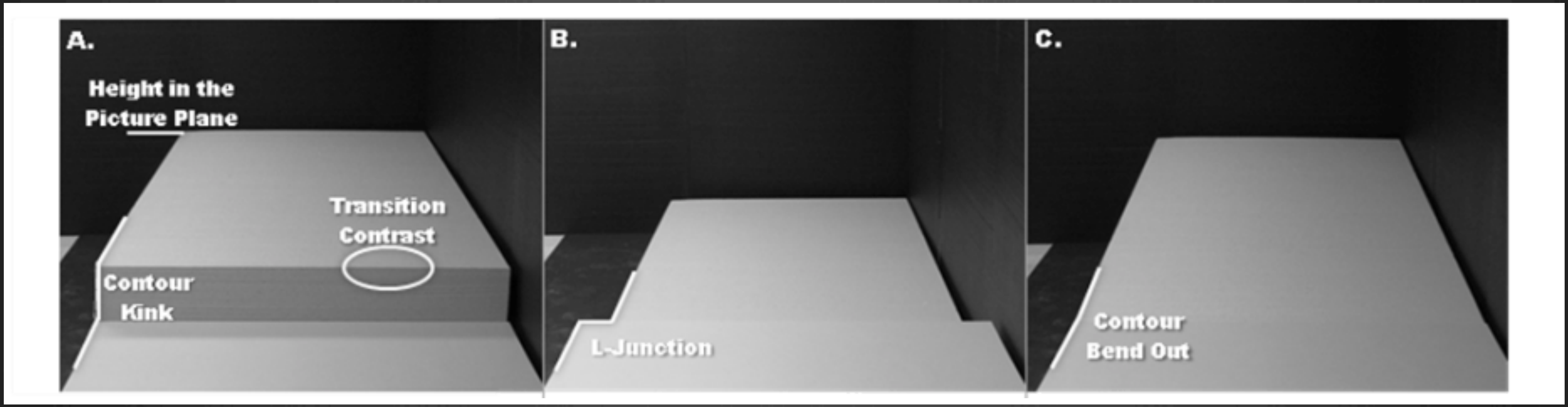


Edge pixel count: 2056

Edge pixel count: 2471

Edge pixel : Maximum change in Low Vision Response Function

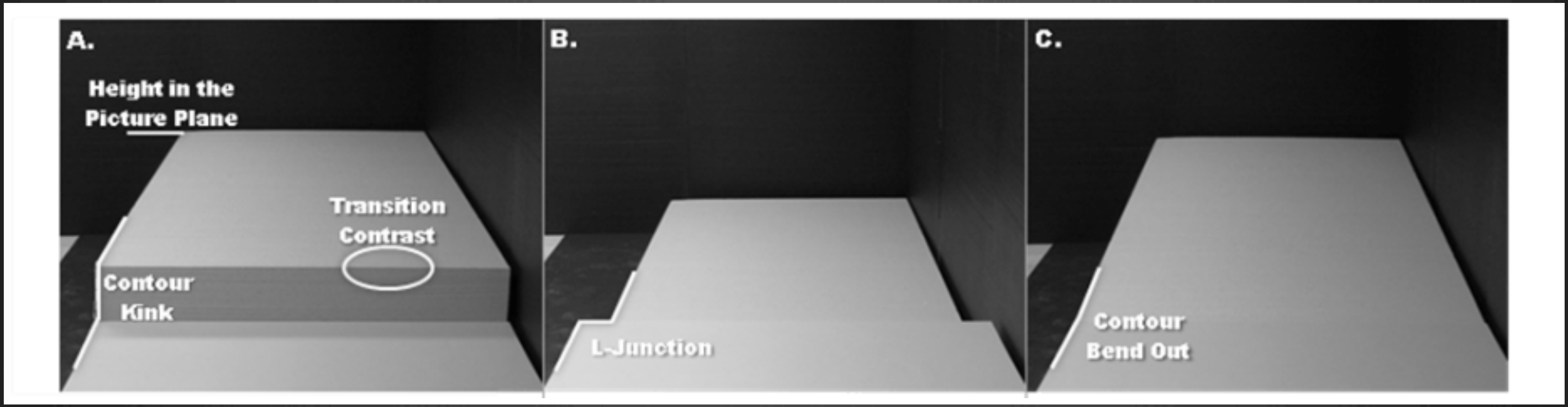
Other VISIBILITY METRICS possibilities



discontinuities in edge contours at step/ramp transitions are important cues for detection:

contour kinks, bends and L junctions

Other VISIBILITY METRICS explorations

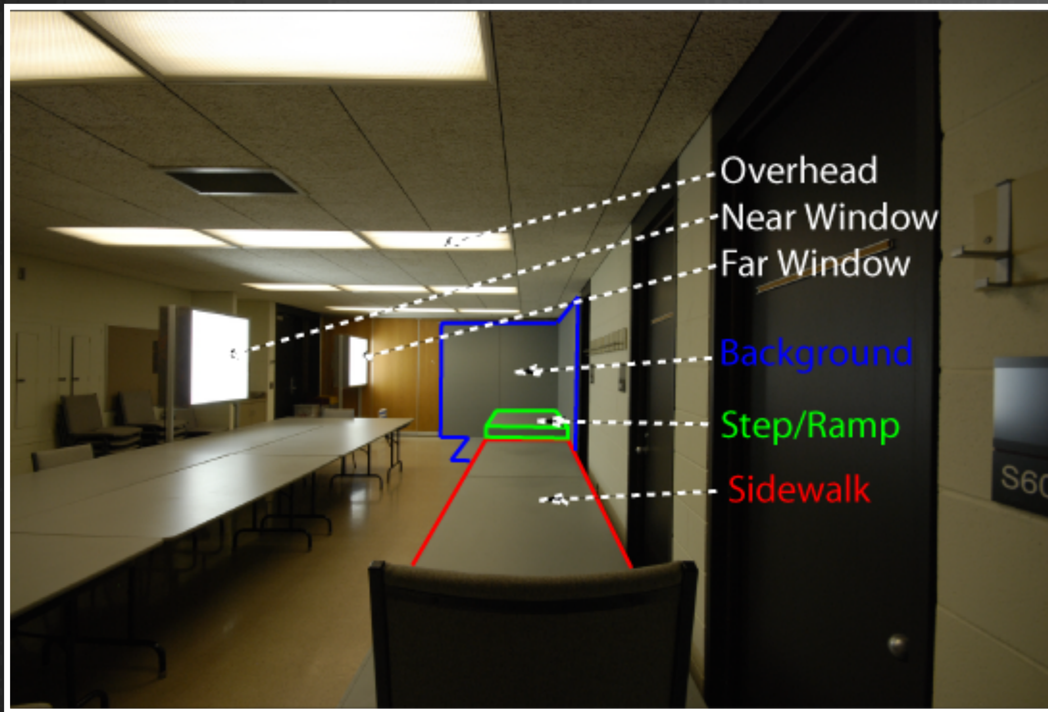


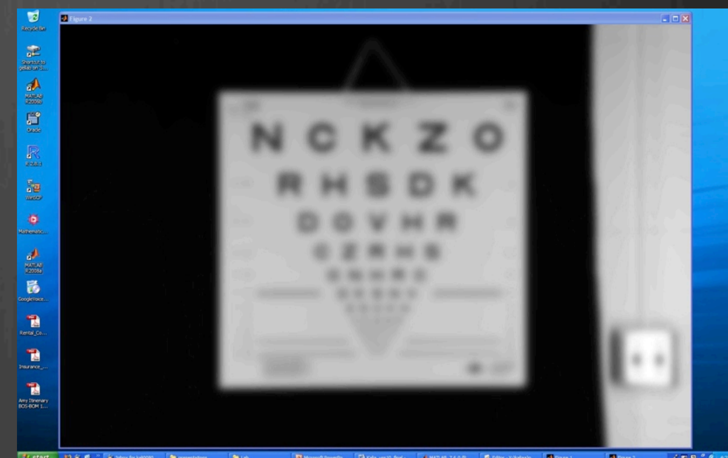
discontinuities in edge contours at step/ramp transitions are important cues for detection:

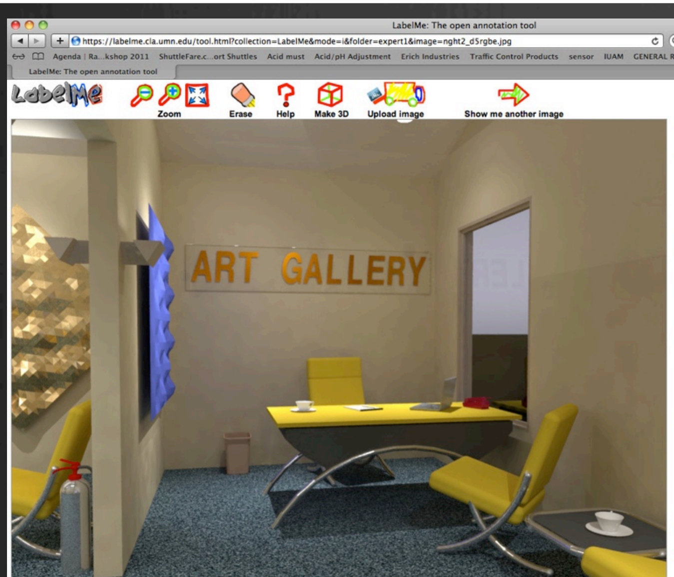
contour kinks, bends and L junctions

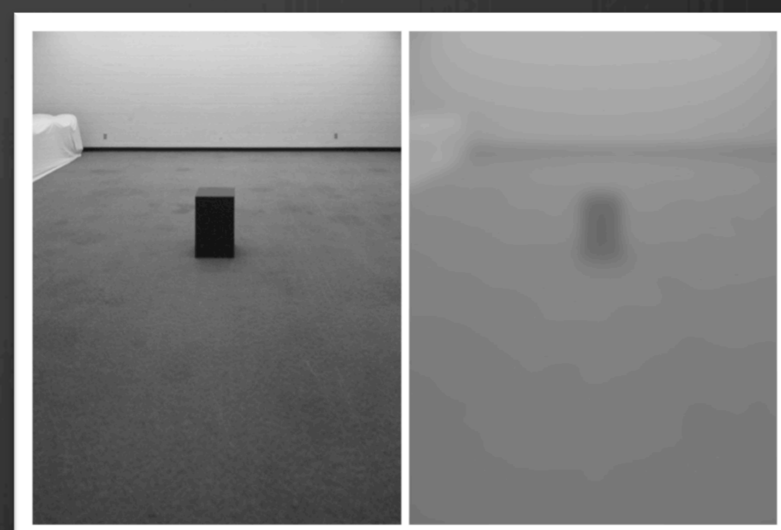
Scan for signature kinks, bends and contours in luminance images

MANY human study experiments >>> validation



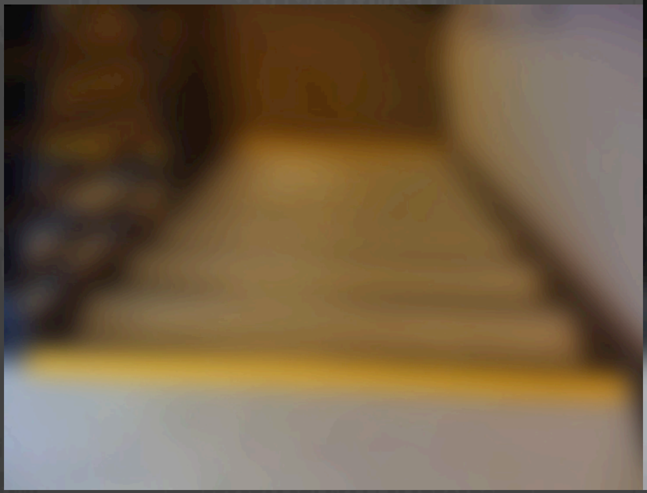




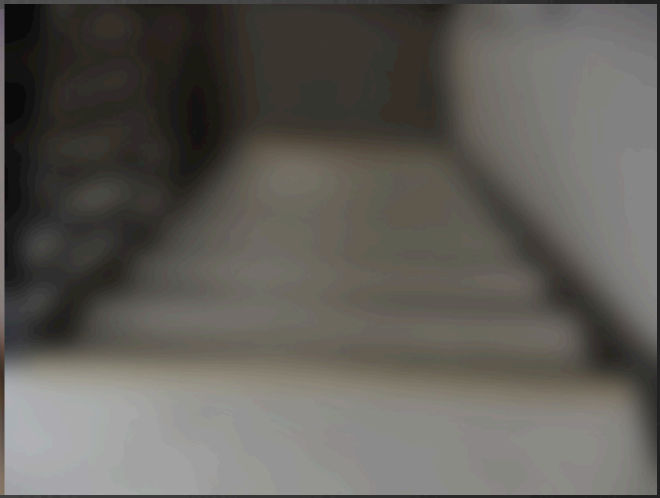


Local case study – LBNL Guest House Stairs (mockup)

6:55 am today



Filtered ~20/600

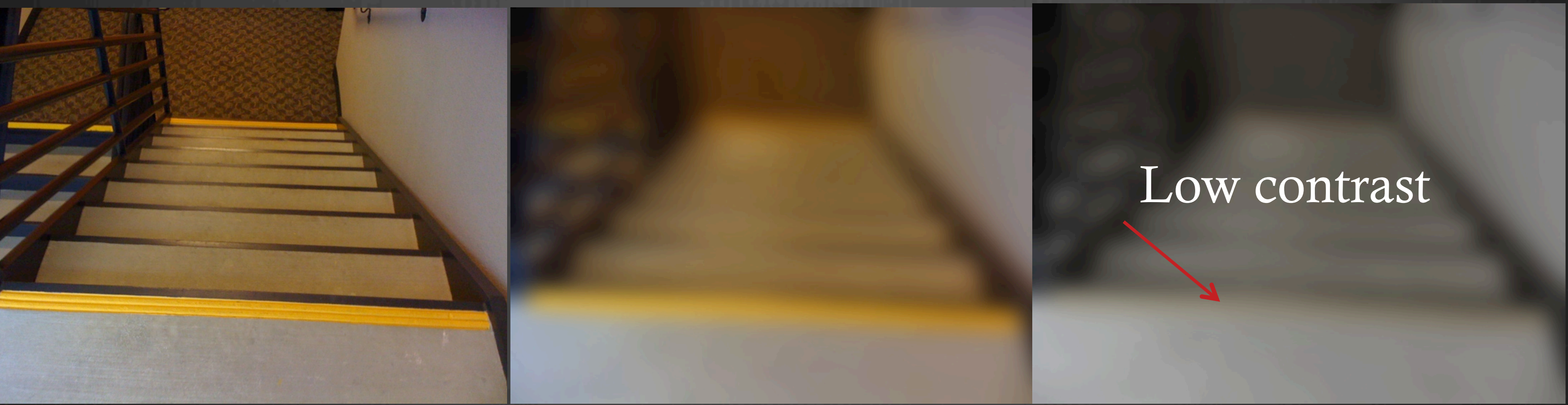


Desaturated

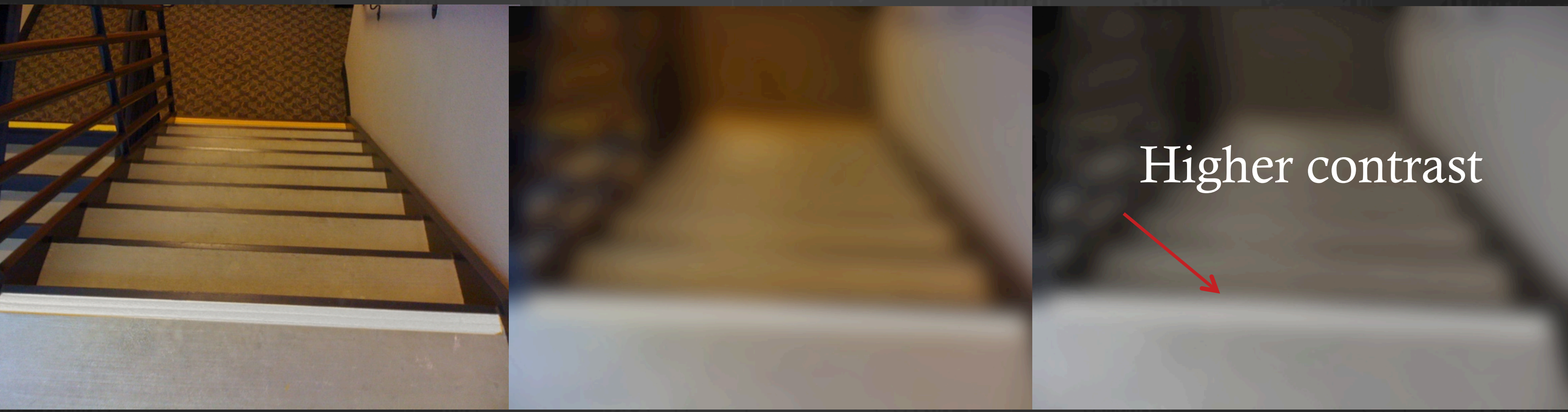
Local case study –
LBNL Guest House Stairs (mockup)

White stripe Filtered ~20/600 Desaturated

Local case study – LBNL Guest House Stairs (mockup)



Color contrast aids 20/20 vision



Luminance contrast aids ~20/600

Visual Accessibility

Challenges:

The balance between safe visual navigation and aesthetics…

Visual Accessibility

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The balance between safe visual navigation and aesthetics…

What acuity range should we design for?

Visual Accessibility

Challenges:

The balance between safe visual navigation and aesthetics…

What acuity range should we design for?

How do you “rate” the visibility of a hazard?

Visual Accessibility

Why should we be concerned?

Visual Accessibility

Why should we be concerned?

LV effects a HUGE & GROWING percentage of the population!

Visual Accessibility

Why should we be concerned?

LV effects a HUGE & GROWING percentage of the population!

To date we typically design only for "normal" vision

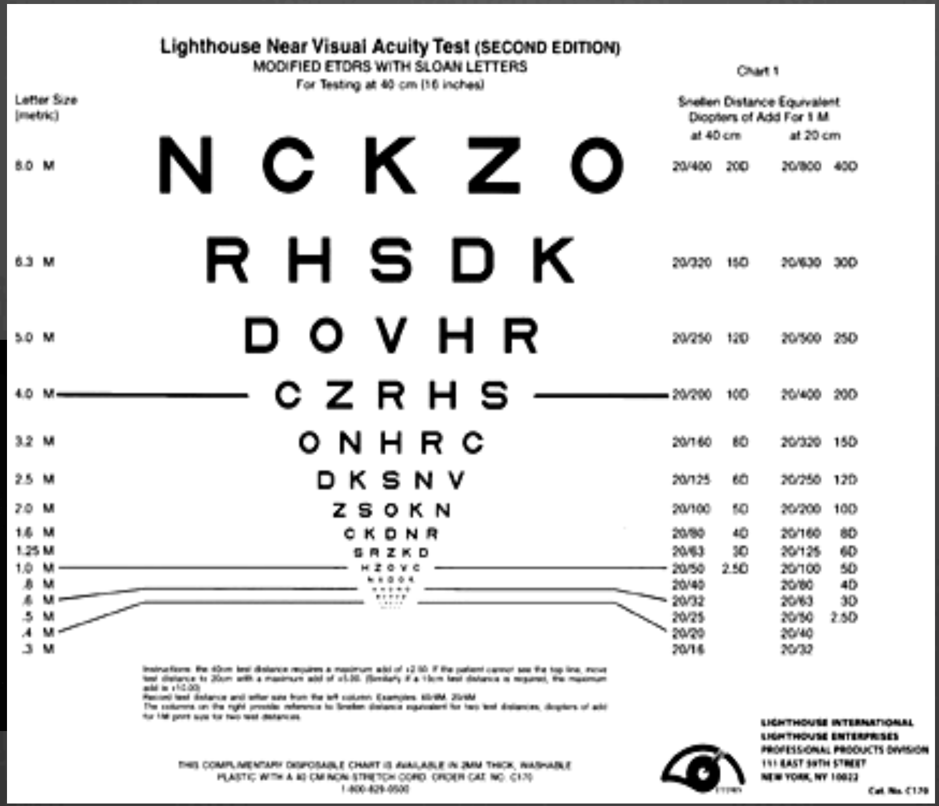
Visual Accessibility

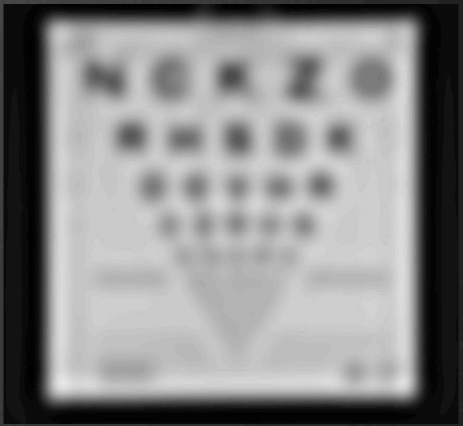
Why should we be concerned?

LV effects a HUGE & GROWING percentage of the population!

To date we typically design only for "normal" vision

What is low vision?





- Fully sighted acuity: 20/20
- Low vision (US definition) 20/40
- Legal Blindness Threshold (US): 20/200
- Utah site foil (sample[1]) : 20/678
- Limit of functional acuity: 20/2000

Low Vision = Useful Vision

- US Low vision population is growing as population ages. Most low vision is age related. 40m > 65yrs
- blindness and low vision: 1 in 28 adults over age 40
- There are many more people with low vision than with blindness. Only 20% of those classified as legally blind have no useful vision
- Majority of those with low vision able to see well enough to perform many tasks under the right conditions
- Legal blindness is not the same as absence of vision

Bygone Stereotype:
ageing equals…

Bygone Stereotype:
ageing equals…rocking chairs

Bygone Stereotype: ageing equals…rocking chairs

- TODAY, individuals with low vision traverse
  Subway stations, libraries, malls, restaurants, spas, parks, airports, casinos, universities, art galleries, gyms…
- Any place you find normally sighted individuals
- This is a rapidly increasing percentage of the population

DEVA's tools aim to assist:

- Fully sighted acuity: 20/20
- Low vision (US definition) 20/40
- **Legal Blindness Threshold (US): 20/200**
- **Utah site foil (sample[1]) : 20/678**

DEVA's tools aim to assist:

- Fully sighted acuity: 20/20
- Low vision (US definition) 20/40
- **Legal Blindness Threshold (US): 20/200**
- **Utah site foil (sample[1]) : 20/678**

Typically persons with acuities up to ~20/600 will tend not use a cane or aids which "indicate" a "blind" person.

They HAVE visual ability but we do not meaningfully include their visual needs in our environments.

Designer focus: interior, lighting, architect…

(possibly used to evaluate future compliance)

Designer work flow:

1. Octree + HDR + LV model + vwrays > scene data

2. Data Analysis

3. Output: rating *(optional visual diagnostics and metrics)*

4. Modify lighting/materials/geometry, return to 1.

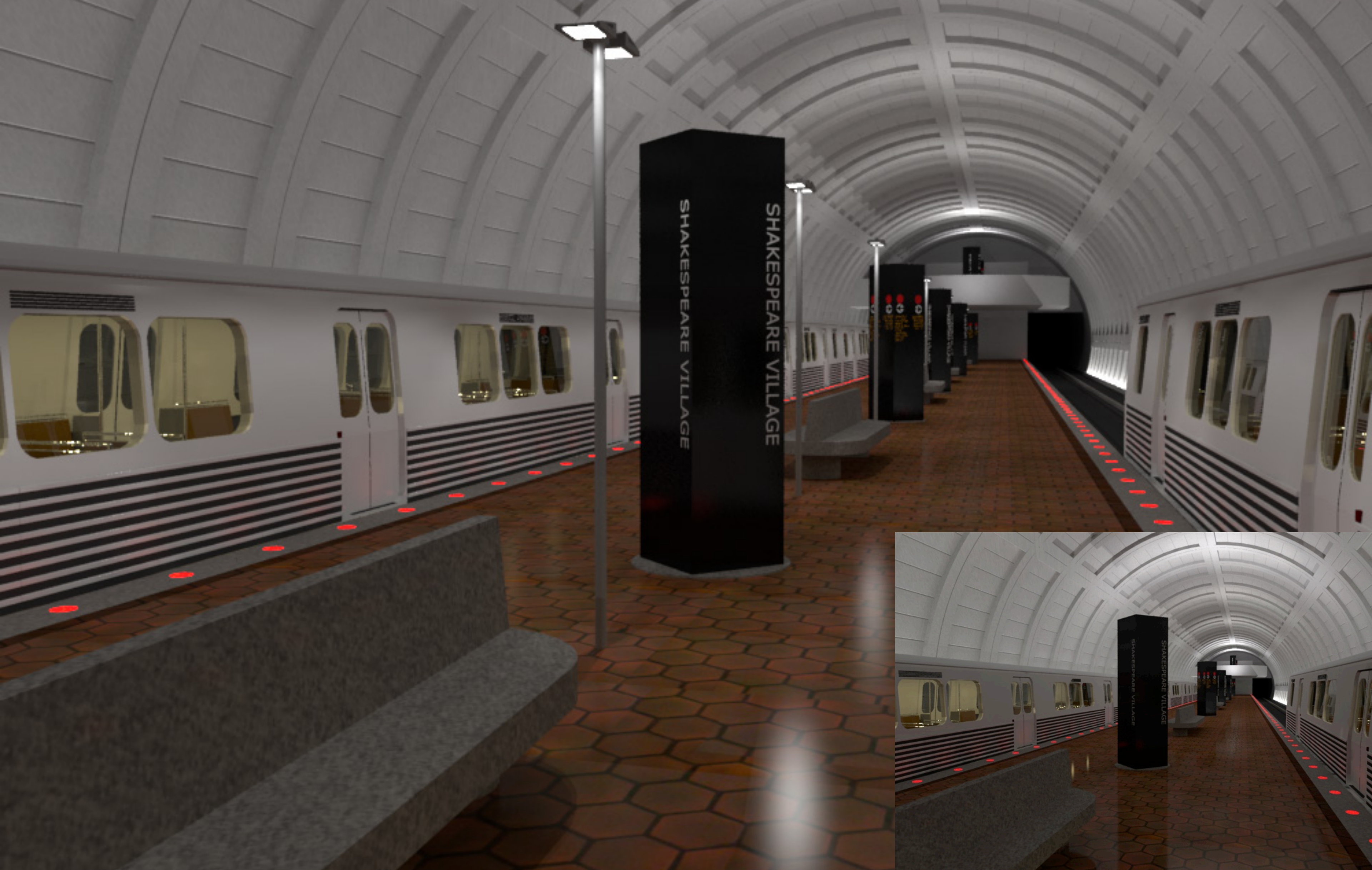
What's in front of you?


SHAKESPEARE VILLAGE
SHAKESPEARE VILLAGE


SHAKESPEARE VILLAGE
SHAKESPEARE VILLAGE

The floor region and granite bench particularly, likely score very high risk at ~20/600 acuity, and modest risk at 20/20 acuity.

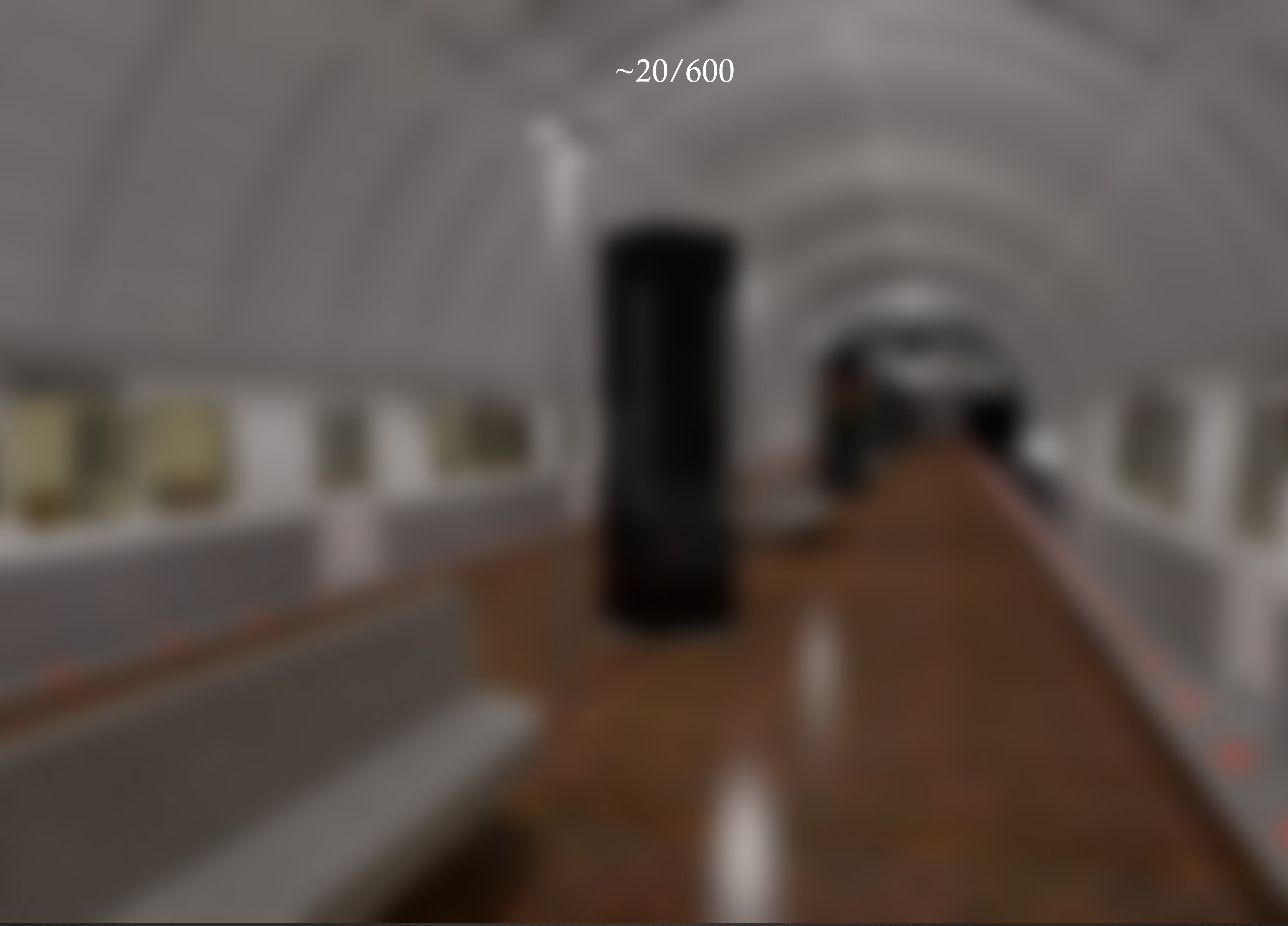
Designer fix #1. Add area light, reduce indirect. N/C in total E



At ~20/600 improved granite bench/floor contrast: modest risk.
Modest > low risk at 20/20 acuity.

Designer fix #1. At ~20/1000 still high risk

Designer fix #2. Boost area light, reduce indirect. N/C in total E

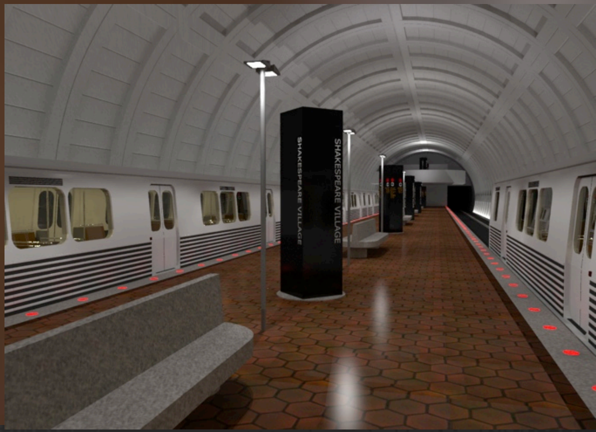

~20/600

Designer fix #2. Modest > Low risk at ~20/600

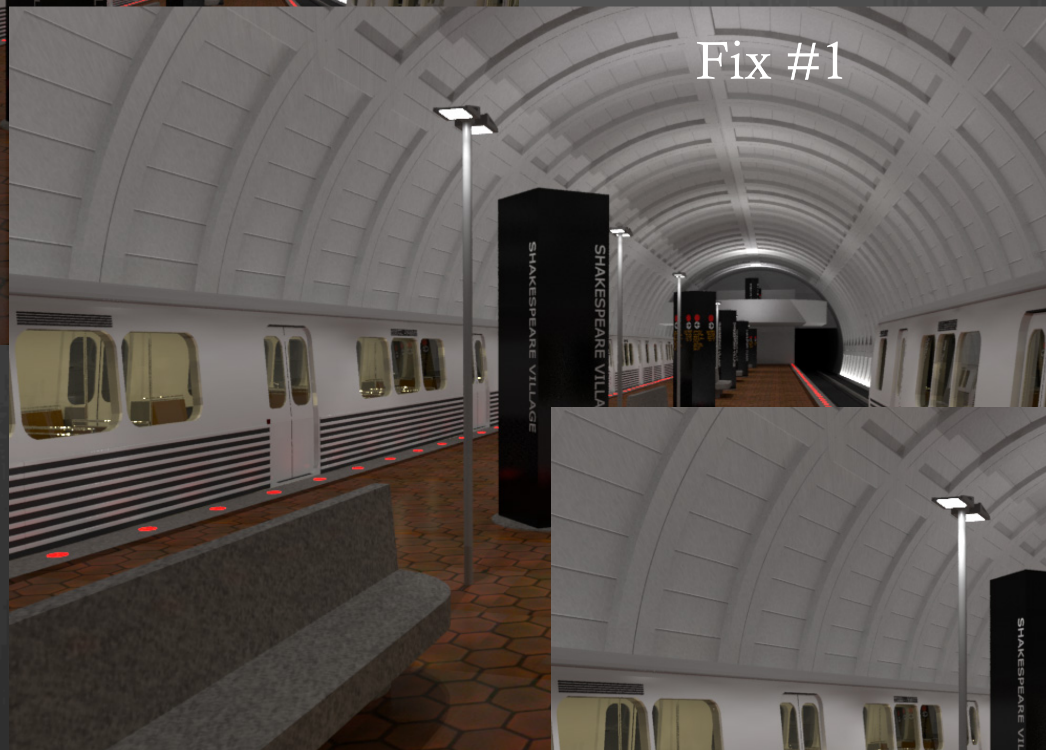
Low risk at 20/20

Designer fix #2. Modest risk at 20/1000

Low risk at 20/20

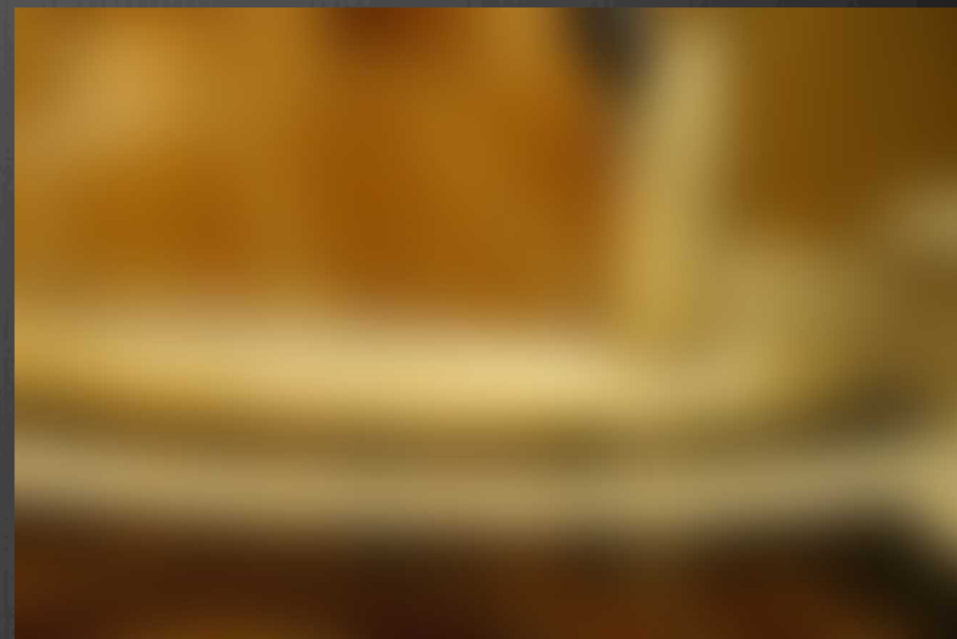



Original challenge


Fix #1
SHAKESPEARE VILLAGE


Fix #2
SHAKESPEARE VILLAGE
Iteratively refined solution

Food for thought…



False Positive Identification

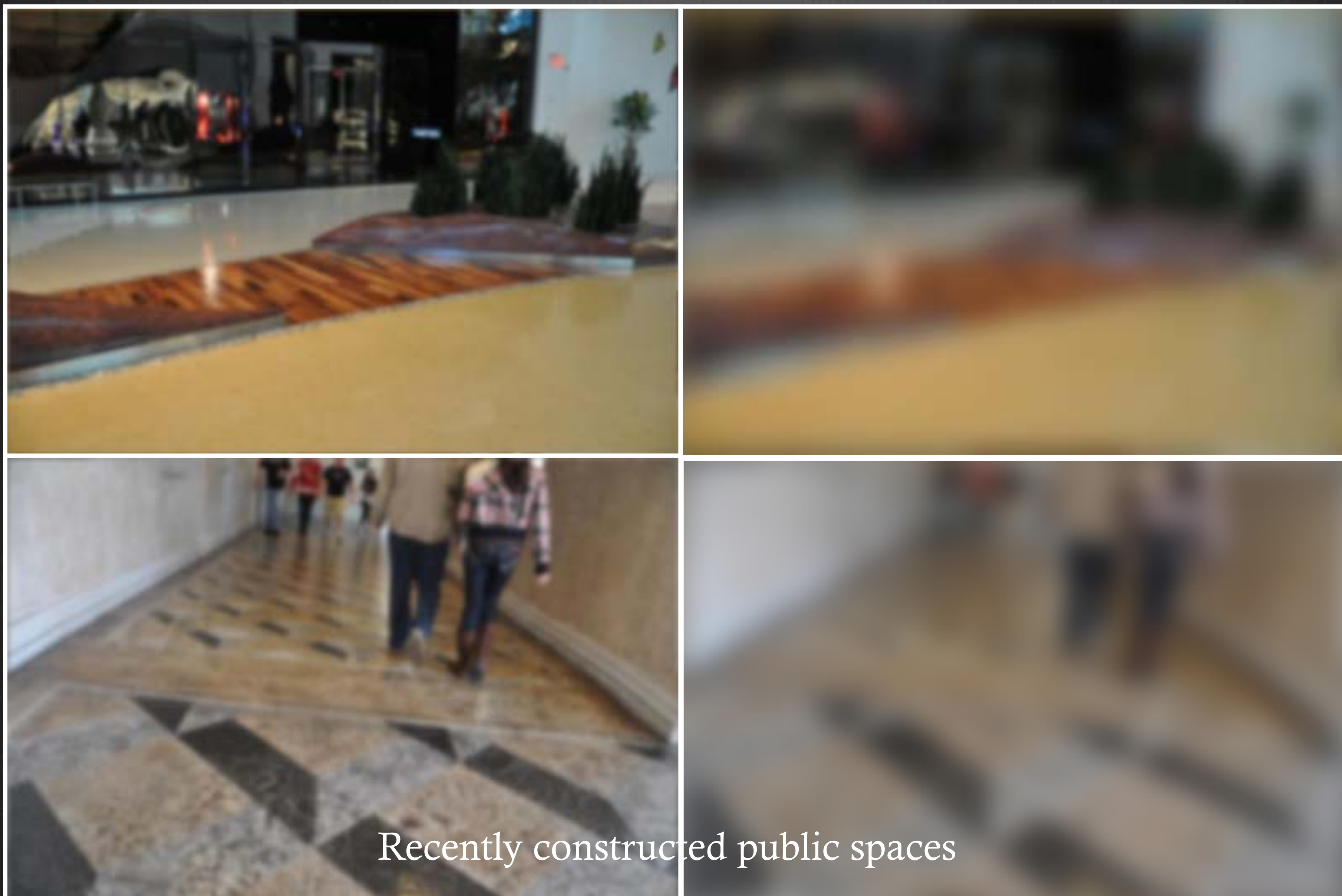
Food for thought…

False Positive Identification

Food for thought…

Specular surface confusion

Food for thought…



Recently constructed public spaces

Food for thought…

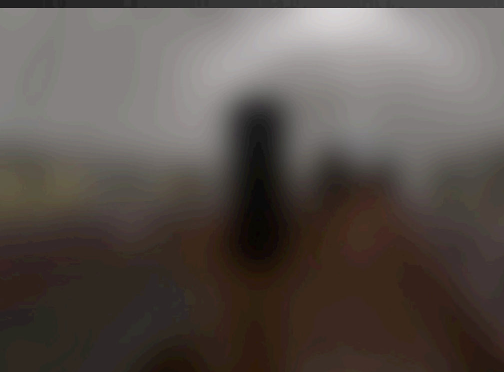

Food for thought…

Current and Future Work

- A better understanding of low vision perception and action involving mobility
- Better methods for simulating the effects of low vision in design systems (recently validated our application of Peli filter)
- Better computational models for automating the prediction of the effects of lighting and other aspects of architectural design on visual accessibility
- Develop a scale to report visual feature detectability
- Integration with the real-world design process

Thank You

DEVA UPDATE



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NIH Grant 1 R01 EY017835-01

Rob Shakespeare
Indiana University PI

Research Team:
Gordon Legge, Chair, Dept. of Psychology & Low Vision Lab, U. of Minnesota PI (Project leader)
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Sarah Creem-Regeher, Dept of Psychology & Visual Perception Lab, U. of Utah
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U. of Utah- Margaret Tarampi, kristina Rand, David Lessard.
I.U. – Chris Wood ,Derek Jones

Radiance International Workshop 2011, August 24-26
Lawrence Berkeley National Laboratories, U.C Berkeley