Quality Control, Settings and Usage Considerations
for Mobile Viewing of Medical Images

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Setting Expectations

This presentation is meant to start a conversation about how to best handle the challenges in mobile image viewing.

- You may have better ideas about how to handle things

- Please feel welcomed to share your viewpoint at the end of this talk.

General Framework for Mobile Viewing Considerations

Mobile Image viewing for clinical patient care decisions made prior to formal radiologic image interpretations and reporting.

General Framework for Mobile Viewing Considerations

Focus on aspects:

- That can be controlled or changed

- That impact the quality of image viewing

- That are relevant for software design, institutional implementation policies and user education

Quality Standards for Medical Image Displays

ACR-AAPM-SIIM Technical Standard for Electronic Practice of Medical Imaging (2014)

Provides recommendation for medical image display including:

-calibration to DICOM grayscale display function

-min and max luminance and luminance ratio

-ambient lighting

-pixel pitch

-quality control

Doesn't differentiate workstation or mobile display

When used for patient care decisions, it is important to provide *assurance* of minimum image quality on mobile devices.

A. Yes, absolutely. A minimum level of image quality should be assured for an image viewing tool used for patient care decisions.

B. Yes, as long as I'm not agreeing to things which interfere with workflow.

C. No, this isn't needed. Users can tell when image quality is degraded and can provide their own assessment and remedy.

D. No, this isn't needed. An average user with a mobile device experiences robustly sufficient default image quality for patient care.

Some lingering questions for research:

1. Can viewers accurately assess when image quality is degraded? Do people know when they are missing something?

2. What are typical usage patterns for mobile device users with no controls or assurance? What are typical image quality levels for use related to clinical decision making?

3. Even if a user can accurately assess image quality degradation, is their judgment accurate about whether or not it is relevant to their patient's care to do something about it?

Mobile Viewing Considerations
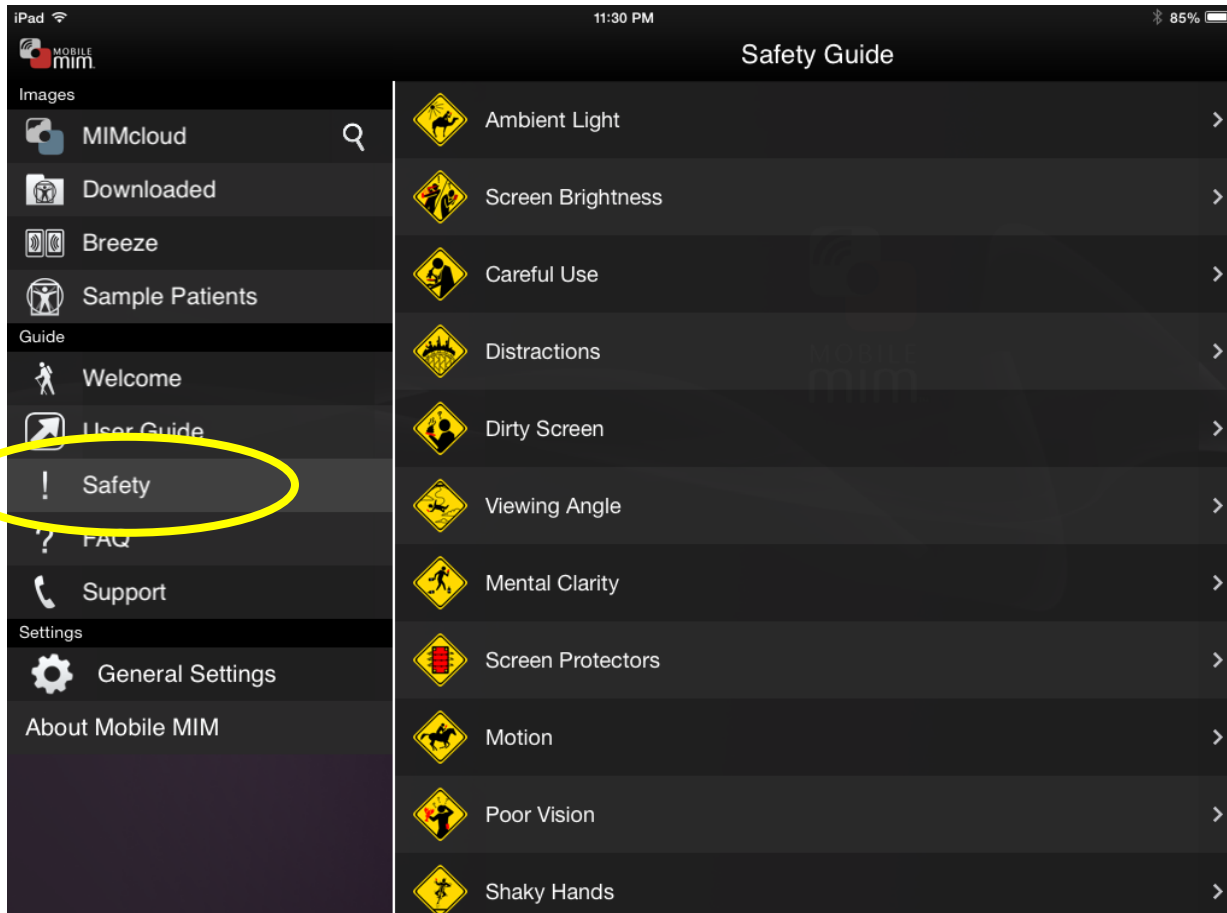
This is not a product endorsement

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Mobile Viewing Considerations

Ambient Light

Ambient light can significantly reduce the contrast of the device, reducing your ability to perceive subtle image detail. Mobile MIM provides a means to Calibrate the device to adjust for its display characteristics, as well as a Verify Lighting tool to test your current environment and help ensure it is within acceptable levels.

- **Recommended Viewing Conditions for diagnostic display are in a dimly lit office environment, away from overhead fluorescent lights and exterior windows. This is an environment similar to a Radiology Reading Room.**

Mobile Viewing Considerations

Dirty Screen

A touch screen is susceptible to dirt and oils and other foreign matter which can be transferred from fingers to the screen surface. This matter will obscure the image data and reduce contrast. Always be aware of your screen and wipe it before and during use if necessary. Carrying a lens cloth is recommended, although many types of clothing are effective at removing foreign matter.

Mobile Viewing Considerations
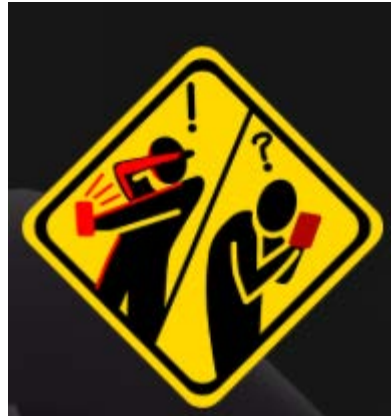
Screen Brightness

To ensure proper luminance during the reading of an image, the device brightness should be set to maximum, and the Auto-Brightness feature should be disabled. This must be configured in your device Settings, not in Mobile MIM. The "Verify Lighting" check will help you notice if the brightness is too low, because the low contrast square will be very hard to see.

Quality Aims for Medical Image Viewing

And the mobile challenges

- Ambient light
- Specular reflections
- Contrast resolution assessment

- Screen Protectors
- Fingerprints

- User Education
- Institutional Policies

Traditional Reading Room Values

1. **Maximize visible information**
2. **Perceptual Linearity**
3. **Consistent Presentation of Images**

- Use Case
- Human Behavior

- Personal Hardware
- Non-standard hardware

- Device brightness
- Display Calibration

For the following mobile viewing use-case,

When ruling out or confirming a suspected finding, in order to direct a timely course of patient care (not a full-diagnostic read)

Which do you think is most important?

A. Maximizing visible information

B. Consistent Image Presentation

C. Both are important but I can live without B if I have to

D. Both A and B are important and should be pursued.

Quality Aims for Medical Image Viewing
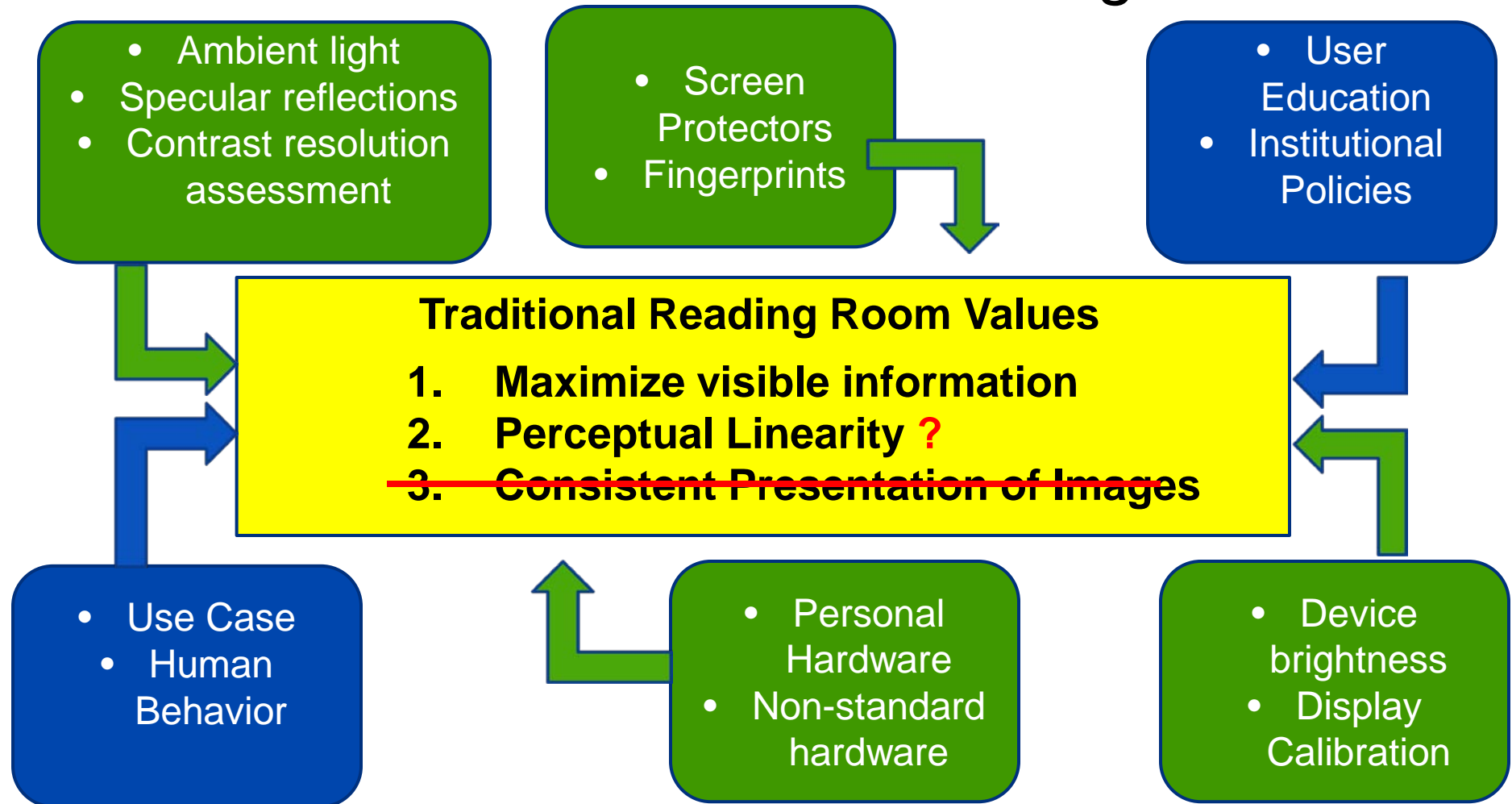
And the mobile challenges

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Traditional Reading Room Values

1. **Maximize visible information**
2. **Perceptual Linearity ?**
3. ~~**Consistent Presentation of Images**~~

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Mobile Image Viewing Values

1. **Maximize visible information**
2. **Perceptual Linearity ?**
3. **Risk Mitigation/ User Education**

- Use Case
- Human Behavior

- Personal Hardware
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Quality Aims for Medical Image Viewing
And the mobile challenges

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- **Patterns of *Human Behavior* are foundational constraints in developing quality assurance tools that require human intervention**

- Use Case
- Human Behavior

- Personal Hardware
- Non-standard hardware

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Which of the following do you think would best describe a typical user interaction with tools to assess or improve image quality on a mobile device?

A. Educated users will voluntarily seek out and complete image quality assessments or calibrations

B. If prompted, educated users will voluntarily complete image quality assessments or calibrations

C. Educated users will probably never access quality tests unless forced, and then they will not be happy about it and wish that %^&* pop-up would go away.

Human Behavior

Making healthy choices -- without thinking

By Theresa Marteau, Special to CNN

Updated 10:26 AM ET, Thu October 18, 2012

But even if the risks are personalized, evidence has shown, such information has little or no impact on behavior.

MENU
Harvard Business Review

DECISION MAKING

Three Keys to (Much) Better Decisions

by **Tony Schwartz**

MARCH 21, 2012

"decision fatigue."

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CUSTOMERS

To Keep Your Customers, Keep It Simple

by **Patrick Spenner** and **Karen Freeman**

FROM THE MAY 2012 ISSUE

SUMMARY	SAVE	SHARE	COMMENT	TEXT SIZE	PRINT	BUY COPIES
			1	▸H		$8.95

"decision simplicity"

DECISION MAKING

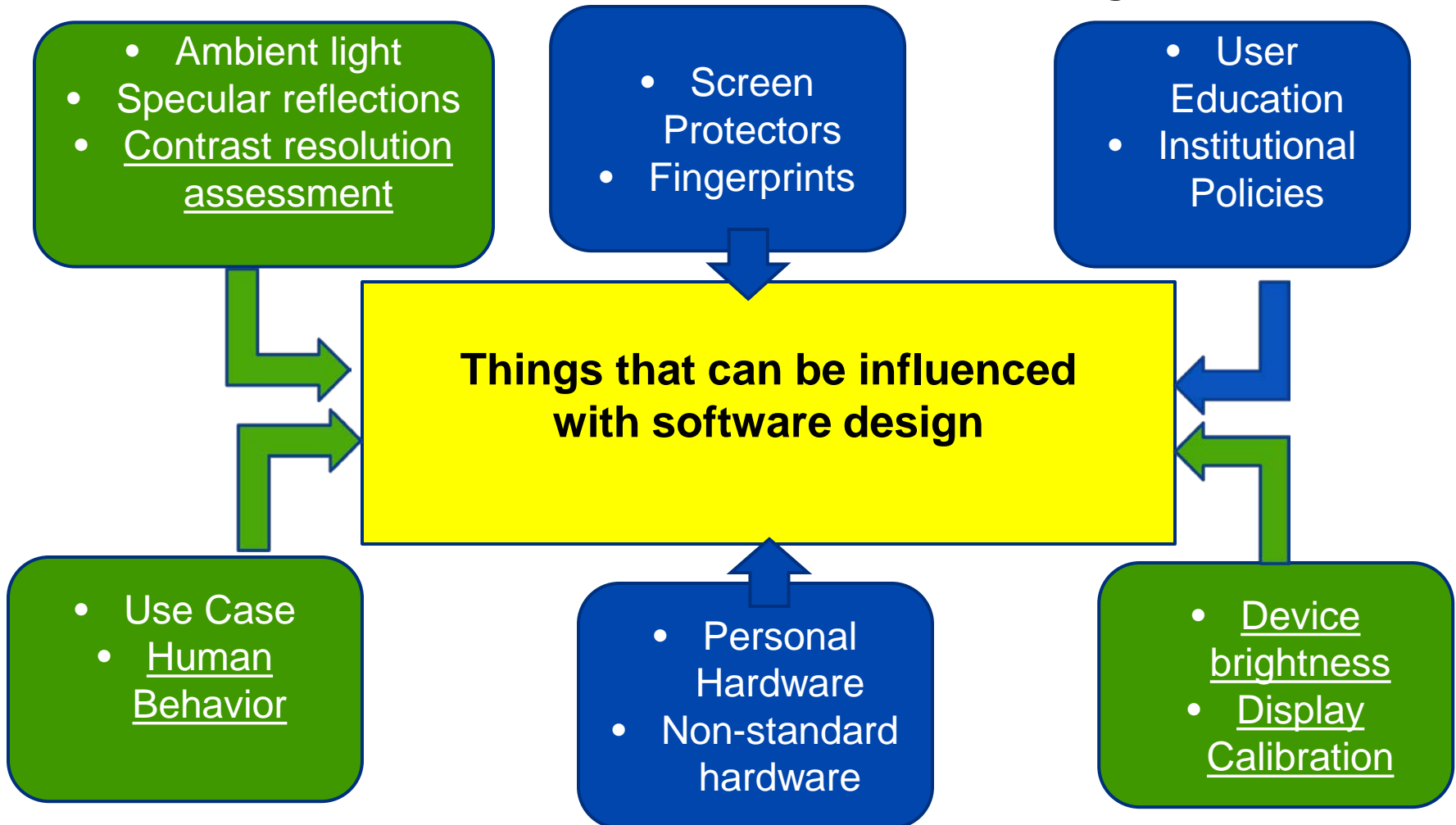## Nudge Your Customers Toward Better Choices

by **Daniel G. Goldstein**, **Eric J. Johnson**, **Andreas Herrmann**, and **Mark Heitmann**

Ill-conceived defaults

When car rental agencies include insurance unless you specifically decline it, or software vendors recommend that you click "next" for a quick install, they're choosing default options for you—covertly or overtly guiding your choices. Well-designed product or service defaults benefit both company and consumer by simplifying decision making, enhancing customer satisfaction, reducing risk, and driving profitable purchases. Ill-conceived defaults (or, simply, defaults no one thought much about) can leave money on the table, fuel consumer backlashes, put customers

Quality Aims for Medical Image Viewing
And the mobile challenges

- Ambient light
- Specular reflections
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- Fingerprints

- User Education
- Institutional Policies

Things that can be influenced with software design

- Use Case
- Human Behavior

- Personal Hardware
- Non-standard hardware

- Device brightness
- Display Calibration

Device Brightness

- Many mobile users set displays to auto-brightness or intentionally dim displays
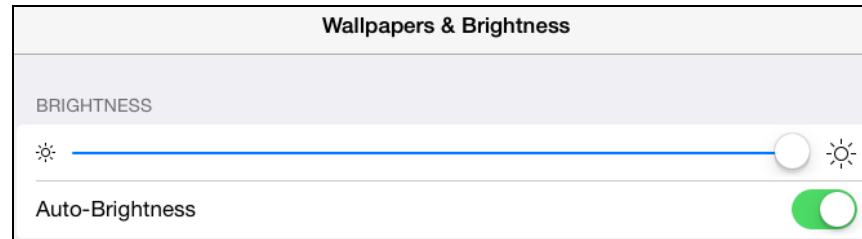
- Mobile viewing software has relied on users to go into settings (iPhone) and change their brightness settings themselves to accommodate medical image viewing.

CONSIDERATION FOR VIEWER DESIGN

Automatically (by default) set the device to maximum brightness.

Display Calibration
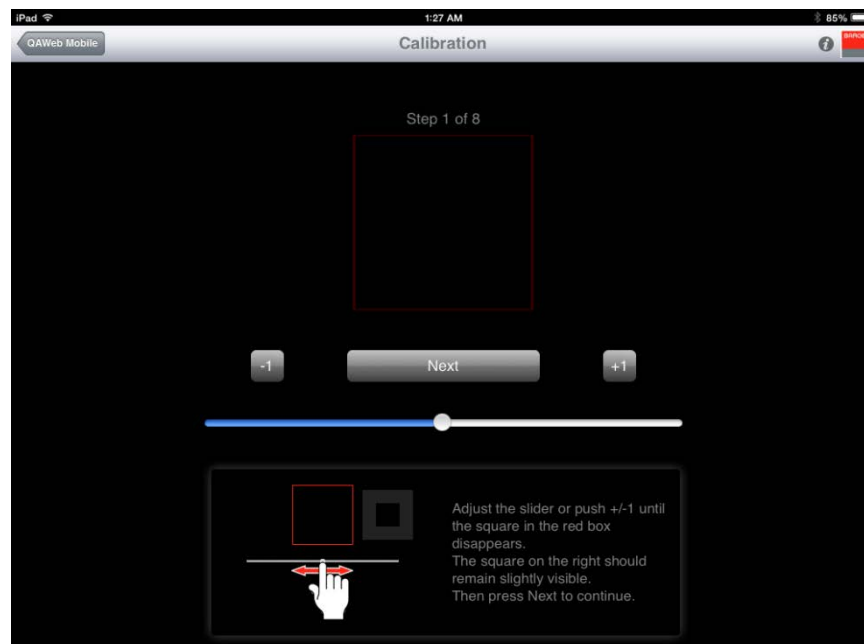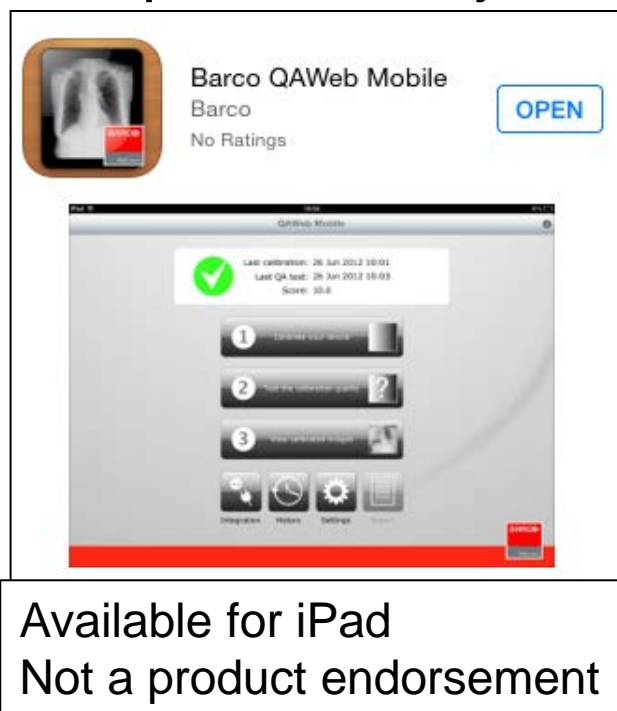## *for maximization of visible information*
or perceptual linearity?

Potential Strategies:

1. Assume or show that native luminance response is sufficient for intended use. Don't bother with calibration.

2. Allow users to interactively modify calibration (within viewing software) in response to object visibility

3. ~~Externally assess luminance and feed to viewer for calibration to a target.~~ *That sounds hard and not clearly superior.*

Display Calibration
for maximization of visible information
or perceptual linearity?
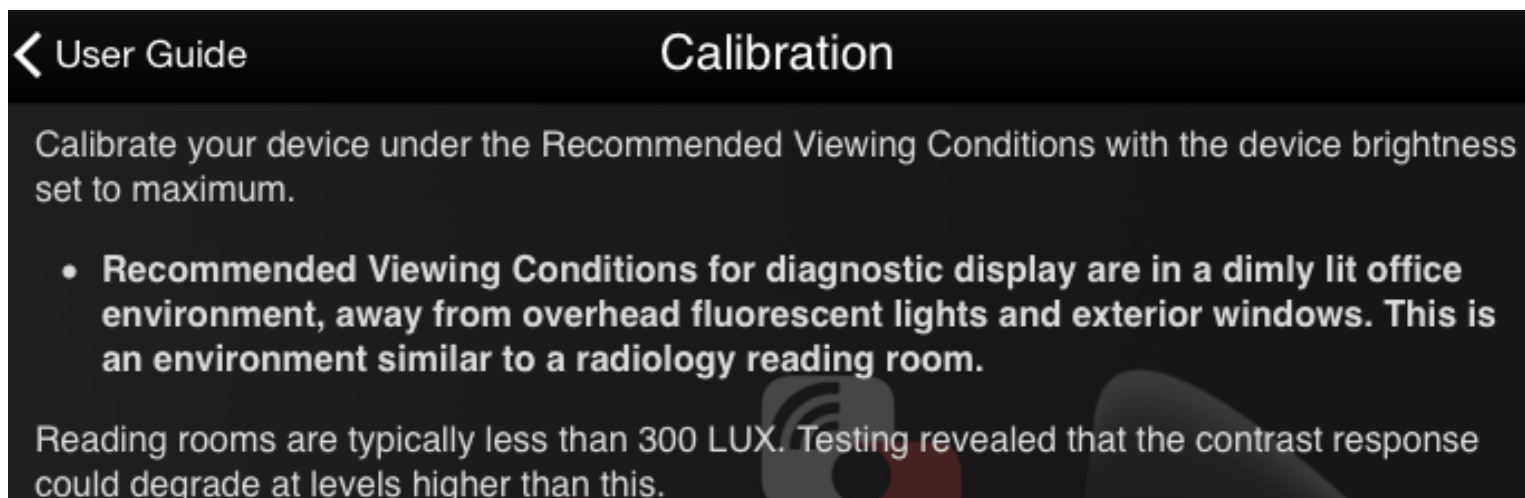
Creating a personalized calibration:

Users interactively modify calibration (within viewing software) in response to object visibility

Available for iPad
Not a product endorsement

Display Calibration
for maximization of visible information
or perceptual linearity?

Calibration concepts:

> **❮ User Guide**　　　　　Calibration
>
> Calibrate your device under the Recommended Viewing Conditions with the device brightness set to maximum.
>
> - **Recommended Viewing Conditions for diagnostic display are in a dimly lit office environment, away from overhead fluorescent lights and exterior windows. This is an environment similar to a radiology reading room.**
>
> Reading rooms are typically less than 300 LUX. Testing revealed that the contrast response could degrade at levels higher than this.

Calibration is not meant to compensate for degradation from excessive ambient light. This would also compromise overall contrast range and object visibility even with calibration.

Display Calibration
for maximization of visible information
or perceptual linearity?

When to calibrate?

1. Initially for a given user and device combination
2. At an interval relevant to significant change in max luminance of the device.

Goal: minimize impact on workflow

Mobile Image Viewing Software can impact which of the following?

1. Ambient Lighting
2. Display Calibration
3. Display Brightness
4. 1 and 3
5. 2 and 3

Under what conditions might it be wise to calibrate a mobile display?

1. In a dim, reading-room type, environment
2. Whenever the lighting changes
3. When the person using it changes
4. 1 and 3
5. 2 and 3

Contrast Resolution Assessment
image quality assurance

Primary Purpose?

To alert or inform user when viewing conditions or device settings are not sufficient for good image quality. May require one of the following actions:

a. Moving to a different location

b. Holding at a different angle, distance

c. Changing max brightness

d. Poor calibration (not relevant if viewer doesn't support calibration)

e. Getting your eyes checked

Contrast Resolution Assessment
image quality assurance

Assessment Types

1. Provide a visual IQ test pattern for user assessment

2. Test the display by asking the user to "find an object(s)"
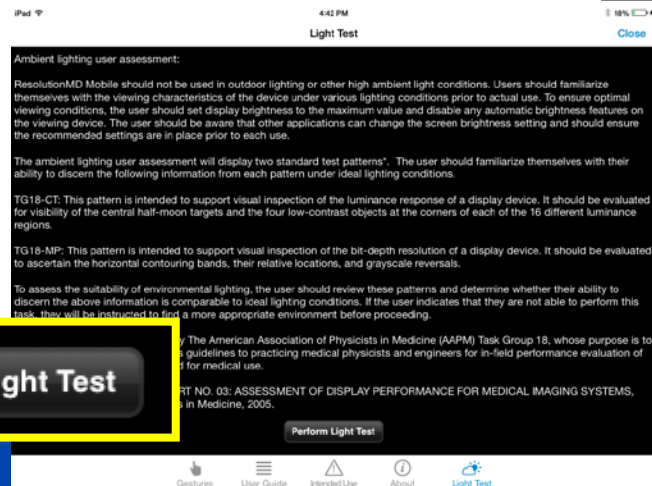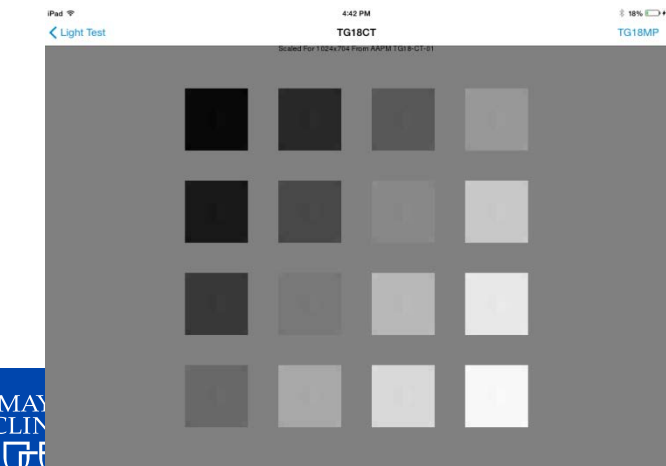
Mode of Interaction

1. Voluntary access when a user is concerned for IQ

2. Prompted access in response to triggering circumstance

Contrast Resolution Assessment
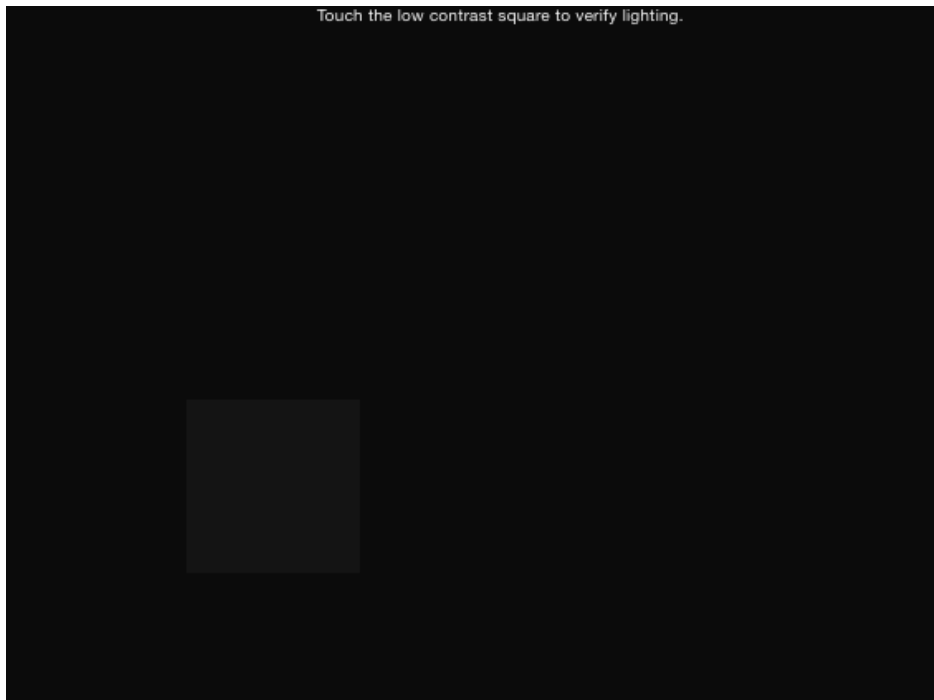## example: *Voluntary Test Pattern Evaluation*
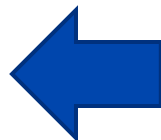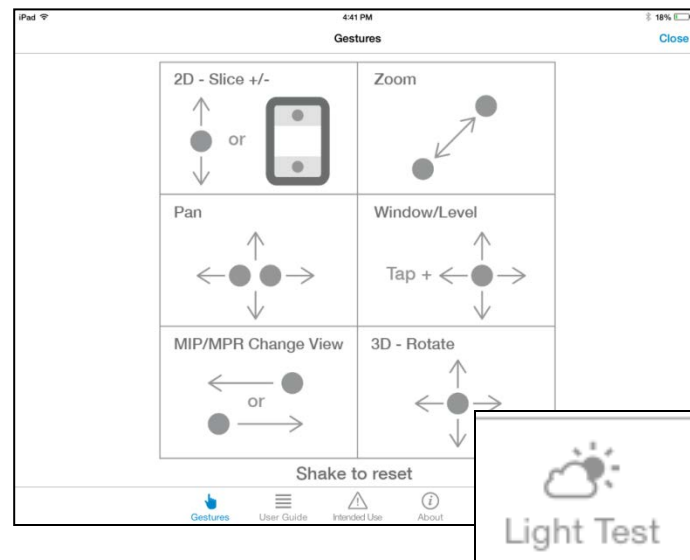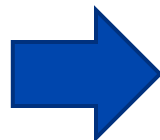
Contrast Resolution Assessment example: *Prompted Object Identification*

Touch the low contrast square to verify lighting.

Touch the low contrast square to verify lighting.

Ideal assessments are quick and closely tied to imaging tasks

Lighting Verification Failed

The environment may be too bright where you are currently located. You can change locations and try again.

Try Again

Help

Read Non-diagnostically

Contrast Resolution Assessment
Triggered Prompts

Trigger for Assessments

1. Required for "diagnostic reads"
2. Prompted when opening the application
3. Prompted at start and at a regular time interval
4. Prompted when camera senses significant deviation from calibration conditions

Aiming for Quality Medical Image Viewing

On mobile platforms

- • Ambient light
- • Specular reflections
- • Contrast resolution assessment

- • Screen Protectors
- • Fingerprints

- • User Education
- • Institutional Policies

- • Set Defaults for Success (enabling high IQ)
- • Require only as much user intervention as needed
- • Provide user education/policies that reflect research and risk tolerance
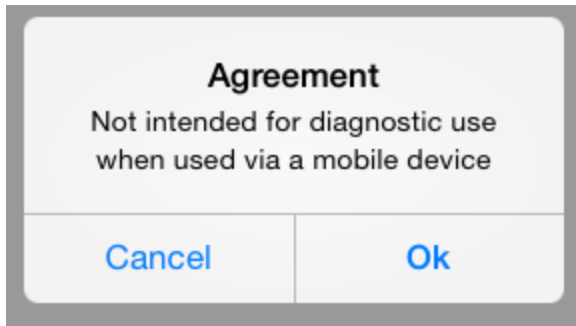
- • Use Case
- • Human Behavior

- • Personal Hardware
- • Non-standard hardware

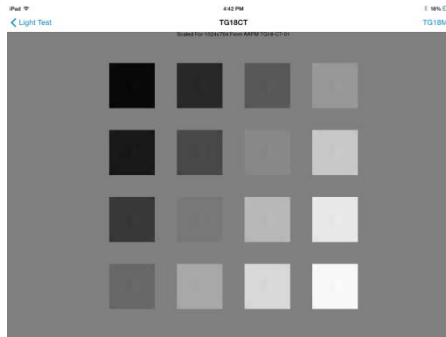- • Device brightness
- • Display Calibration

MAYO CLINIC

Quality Control, Settings and Usage Considerations

Knowing that mobile Image viewing will be used for clinical patient care decisions prior to formal radiologic image interpretations and reporting, what should we choose?

A) Not even try:

B) Provide a means for the user to assess quality if concerned.

C) Provide assurance of a default standard of quality?

Questions & Discussion