Surge in Remote Reading Due to the COVID-19 Pandemic and the Need for Optimized Remote Reading Environments

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INTRODUCTION

In order to maintain social distancing and workplace safety during the COVID-19 pandemic, many radiologists began to interpret studies via remote reading on home workstations. The initial aim of this study investigates how ambient light levels in home reading environments affect radiologists' ability to detect low contrast image features.

METHODS

To understand the factors that impact image interpretation in a remote environment, radiologists were asked to provide their home "reading room" layout, including the position of their workstation relative to other light sources.

A test pattern was developed on PACS to assess minimum detectable contrast at six different display background gray values (0%, 4%, 10%, 20%, 60%, and 98%). Capital letters of varying contrast were randomly placed on the backgrounds (See Figure 1). Physicians reported the lowest contrast letter they were able to see, as well as time of day, sunlight conditions, and display type (See Table 1).

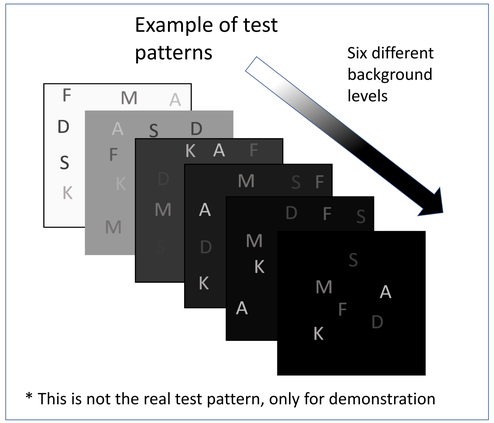

Figure 1. Examples of test patterns with six different background levels from dark to bright over the full luminance range. Capital letters with different contrast are randomly chosen and placed. The faintest contrast is ±1 from the background. Four different sets of test patterns are developed for each background level to reduce the variability from the reader.

Figure 2. Example of measuring ambient light with an inexpensive photometer calibrated with an in-house photometer with NIST-traceable calibration.

RESULTS

	Display gray value:						Reading conditions:			
	0%	4%	10%	20%	60%	98%				
Reader 1	1	1	1	1	1	1	MG	Overcast	Home	Daytime
Reader 2	1	1	1	1	1	4	MG	Overcast	Home	Daytime
Reader 3	1	1	2	2	3	1	MG	Overcast	Home	Evening
Reader 4	1	1	1	1	1	2	MG	Overcast	Home	Daytime
Reader 5	1	1	1	2	1	1	MG	Overcast	Home	Morning
Reader 6	1	1	1	1	1	1	MG	Overcast	Home	Daytime
Reader 5	4	3	2	2	1	1	MG	Sunny	Home	Morning
Reader 7	2	2	1	1	1	1	MG	Sunny	Home	Morning
Reader 8	1	1	1	1	1	1	MG	Unknown	Home	Daytime
Reader 9	2	1	1	1	1	2	MG	Unknown	Office	Evening
Reader 10	4	7	2	2	3	3	CD	Unknown	Reading Room	Daytime
Reader 11	2	1	1		1	2	MG	Unknown	Reading Room	Evening
Reader 12	1	1	1	1	1	1	MG	Overcast	Home	Morning
Reader 13	1	2	1	1	1	2	MG	Overcast	Home	Daytime
Reader 14	4	10	5	2	3	1	MG	Sunny	Home	Daytime
Reader 14	3	2	1	1	1	1	MG	Sunny	Home	Daytime
Reader 15	3	2	1	1	1	1	MG	Unknown	Home	Evening
Reader 16	25	15	10	10	1	5	CD	Overcast	Home	Daytime
Reader 16	4	10	5	5	5	5	CD	Overcast	Home	Morning
Reader 16	15	7	3	1	3	10	CD	Overcast	Home	Evening
Reader 16	2	2	2	2	3	2	MG	Unknown	Reading Room	Daytime
Reader 17	1	2	1	1	1	2	MG	Unknown	Home	Evening
Reader 18	1	1	1	1	3	1	MG	Overcast	Home	Morning
Reader 19	4	2	2	2	3	2	MG	Overcast	Home	Daytime
Reader 19	2	2	1	1	1	1	MG	Sunny	Home	Daytime
Reader 20	1	2	2	1	1	1	MG	Sunny	Unknown	Daytime
Reader 21	1	1	1	1	1	1	MG	Overcast	Home	Morning
Reader 22	1	1	1	1	1	1	MG	Overcast	Reading Room	Morning
Reader 23	1	1	1	1	1	1	MG	Sunny	Reading Room	Daytime

MG: Medical-grade display; CD: Consumer-grade display

Table 1. Data table showing 23 readers and the minimum detectable contrast on a variety of backgrounds (Fig. 1). Letters at contrast levels of 1 or 2 should be detected at all background levels, based on what is achievable in an actual reading room, reading on a medical-grade display. Higher numerical values reflect failure to detect lower contrast letters on the test images.

Initial data from 23 radiologists was collected and analyzed (Table 1). Multiple trends which limit ability to detect low contrast image features included: 1) high ambient light levels in home reading environment 2) sunny conditions during study interpretation 3) consumer grade display monitors.

Physicians who initially failed to detect low contrast letters at background gray values of 0% and 4% were provided with a calibrated lux meter (Fig. 2) and asked to make alterations to their home reading environment including room layout, blackout curtains, and monitor position. Physicians were asked to reassess the test pattern and ambient light level and provide the data for further analysis.

Reader 14	4	10	5	2	3	1	MG	Sunny	At home	Daytime
Reader 14	3	2	1	1	1	1	MG	Sunny	At home	Daytime
Reader 16	25	15	10	10	1	5	CD	Overcast	At home	Daytime
Reader 16	4	10	5	5	5	5	CD	Overcast	At home	Morning
Reader 16	15	7	3	1	3	10	CD	Overcast	At home	Evening
Reader 16	2	2	2	2	3	2	MG	Unknown	Reading Room	Daytime
Reader 19	4	2	2	2	3	2	MG	Overcast	At home	Daytime
Reader 19	2	2	1	1	1	1	MG	Sunny	At home	Daytime

Table 2. The above readers initially had poor results and subsequently repeated the test after adjusting their home "reading room" configuration. Prior to retesting, they utilized the photometer (Fig. 2) to ensure ambient light was less than 75 lux. The highlighted test sessions represent repeat testing with appropriate ambient light levels.

CONCLUSIONS

Our study finds that high ambient light levels within individual remote reading environment setups may limit radiologists' ability to detect low contrast image features. Our study finds that test patterns and ambient light measurements with low-cost in-house calibrated lux meters may be an easy and cost-effective strategy to ensure that home reading environment light conditions reflect those in on- site reading rooms. In conclusion, preliminary data suggest that remote reading environment ambient light levels 75 lux or lower improve accuracy and consistency of image study interpretations, specifically with regard to detecting low contrast image features. Moving forward, we intend to make this test pattern a quarterly requirement for all remote readers to ensure consistency of study interpretation and improve patient care.