

A Sample NeuroSafe Environmental Report

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What is Neuromechanical Safety?

Just as certain kinds of air or water can be safe, or poisonous, certain environments can by their very structure be safe or unsafe for a human (or even animal) nervous system, because of the patterns they contain. The concept “neuro-safe” is meant to protect nervous systems from such damaging information, and the NeuroSafe trademark is meant to keep that meaning uncorrupted.

Fortunately, we have measurement principles that can tell us how neuromechanically safe an environment is. The principles for deciding what is and is not neuromechanically safe are not up for sale, nor up for debate. Those principles are deeper than mere evidence, being based all the way down in physical laws of information flow through space and time. Those are the laws and principles we can use to protect ourselves and those we care about from environments and interactions which undermine our nervous systems.

One can use scientific, statistical measurements of anything a brain might consume: smells, tastes, sounds, mechanical vibrations, reflected light.

About This Report

This report describing principles of neuromechanical safety attempts that feat uses standard scientific measurements which could be applied equally to light, sound, or physical vibration.

Light will be the focus in this report, in particular comparing sunlight, incandescent “Edison” bulbs, and LED lights that one might consider buying. If you as a customer have paid additional fees for personalized evaluation, this report will also contain measurements of your specific devices side by side with the “official” ones, to compare in context.

3rd section: Light as Vibrations

By measuring how artificial stimuli (like LED lights) are different from natural ones, we can decide roughly which ones are most likely to irritate our brains and senses. The most general approach to creating neuromechanically safe environments is a simple principle: the more unnatural the profile, the more irritation. The most specific approach is to measure your actual environment, using instruments and techniques like those described above.

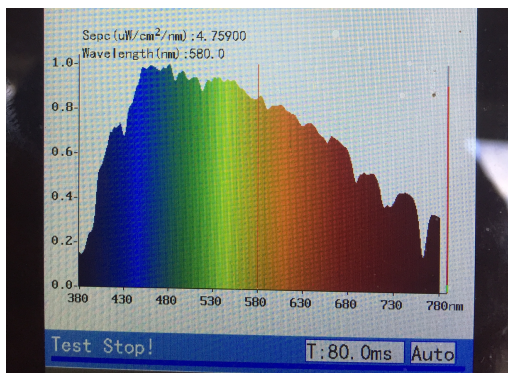
One can use scientific, statistical measurements of anything a brain might consume: smells, tastes, sounds, mechanical vibrations, reflected light. In this paper we stick to light, and further restrict our measurements to the quality of light itself, in terms of color spectrum and time variation (which can be measured in complementary ways).

Our brains evolved to see by sunlight, making it their native, optimal interface. Anything different from natural sunlight is bad in proportion to the difference.

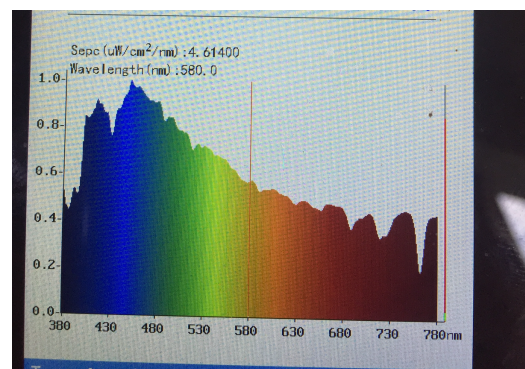
Color Spectrum

Sunlight is white, the blue sky is blue, and some LED lights are extra-blue. How is that measured?

Using a commercial color spectrometer (Hopoocolor model OHSP-350F) you can see how light intensity varies with color. On the left is natural sunlight, on the right the “blue sky” near the sun on the same day:



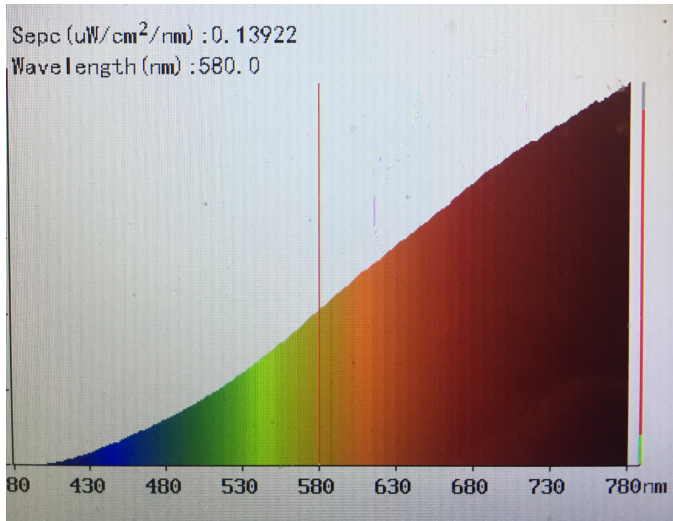
Natural sunlight



“blue sky”

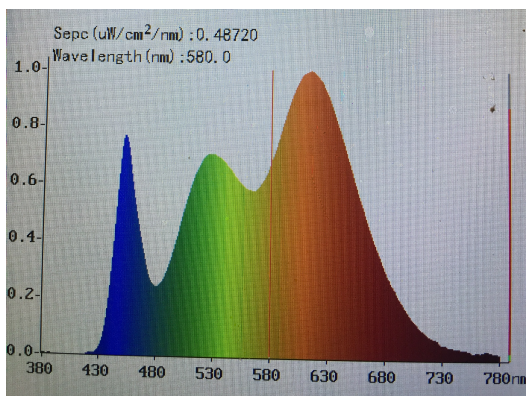
You can see on the left of each graph that the blue sky has more intense blue light than does natural sunlight, although both curves are mostly continuous, with only small notches, as is usual in Nature.

Next up is the safest form of artificial light, from the glowing-hot wire of a halogen work light (which is the same as an “Edison bulb,” but brighter and whiter). The curve is especially smooth and notch-free, with very little blue light relative to red and orange:



White-hot incandescent halogen work light, whose smooth shape and lack of blue make it especially benign

The final and least neurosafe light source is a LED, whose extra blue appears as a shark's-tooth spire at left. The intense blue is there on purpose for energy efficiency (it powers the green, yellow, and red), but no natural light source has so much blue, so our eyes become both fascinated and anxious:



“Halo” brand residential LED can light (model RL4069S1EWHR), with an extra-blue shark’s tooth spire.

Speed-of-change

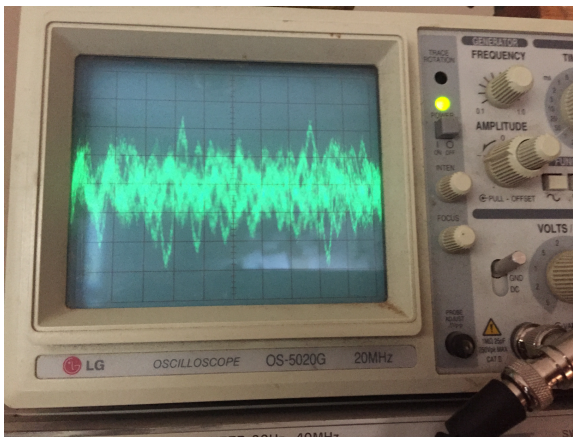
Humans know our eyes see color. But our visual systems are even more sensitive to the speed and timing of coordinated changes, such as the nano-second synchrony among pixels on a screen which make moving pictures move. Paradoxically, such subtle timing signals are so important that we can't see them consciously.....that's why we can see motion and shape in a TV or video image, while not seeing the flashing of the whole frame which happens thousands of times slower.

This is a huge problem for artificial lighting like LEDs, whose light can switch between off and on a million times faster than we can see. Natural sunlight doesn't do that, and incandescent lights don't do it enough to be a problem. LEDs do.

Below we measure those quick subtle changes for the same light sources as above: natural sunlight, a halogen worklight, and the dimmable LED can-light. We will use both standard measurement methods, time-domain and frequency-domain.

Time-domain oscilloscope traces

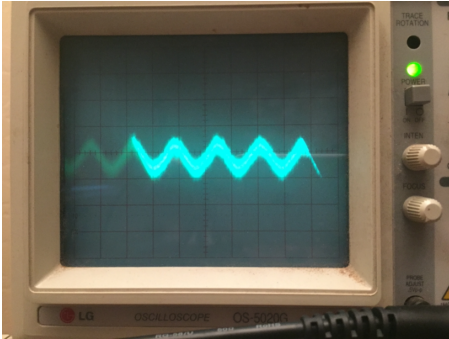
We connected our high-speed light sensor to an oscilloscope, whose blue dot moves sideways very fast, and moves up and down according to light intensity. The first measurement was of natural sunlight, which we expect to be entirely unchanging. But no! While about 99% of the light from the sun was constant, atop that was a small modulation, amplified here to be visible:



Intensity variation of sunlight (amplified, 2 ms full scale)

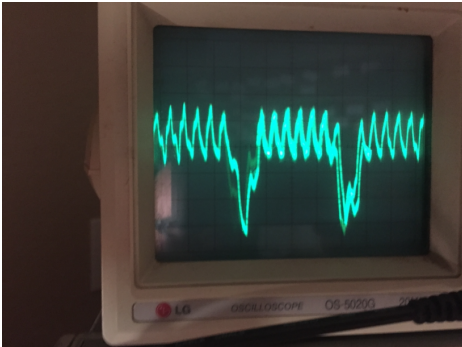
On this oscilloscope trace (spanning 2/1000 of a second from left to right), the variation of sunlight intensity, probably due to atmospheric turbulence, appears on the oscilloscope as a scrambled, noisy mess. If you listen to that same signal through headphones, it sounds like a slightly musical hiss.

Next up is the incandescent worklight, whose intensity as expected varies (by about 10%) at 120Hz, because with the 60Hz frequency of electric wall-current heating the wire:

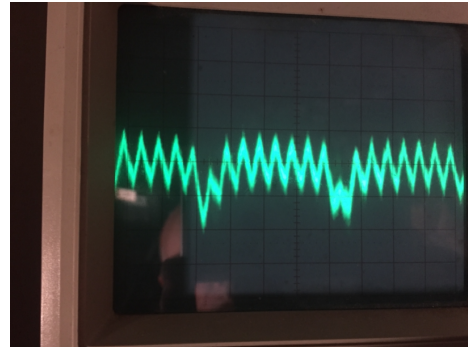


Incandescent halogen work-light varies at 120 Hz

The most dramatic time-variation comes from the LED can-light, which has a very fast 1000Hz sawtooth variation atop a 120 Hz baseline:



LED can-light at maximum intensity



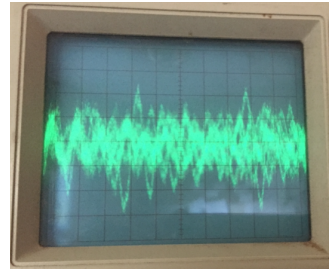
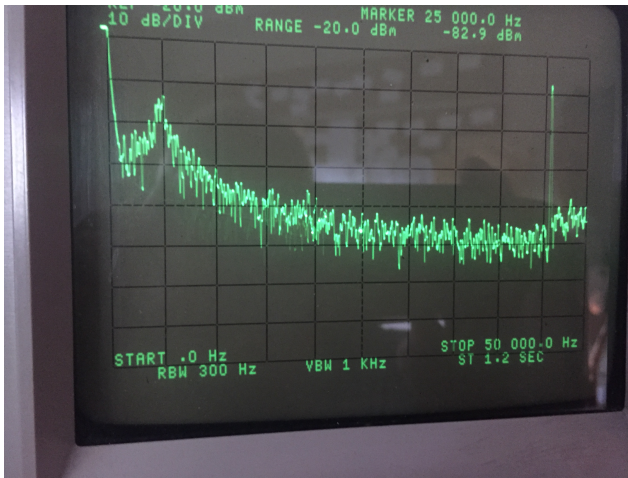
The same can-light dimmed about 50%

No light source in Nature can change so fast, making this kind of light pattern a prime candidate for inducing headaches, anxiety, and sleeplessness.

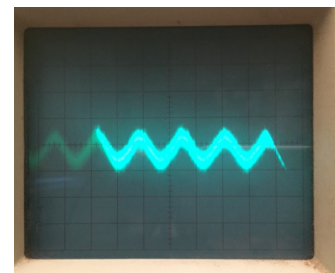
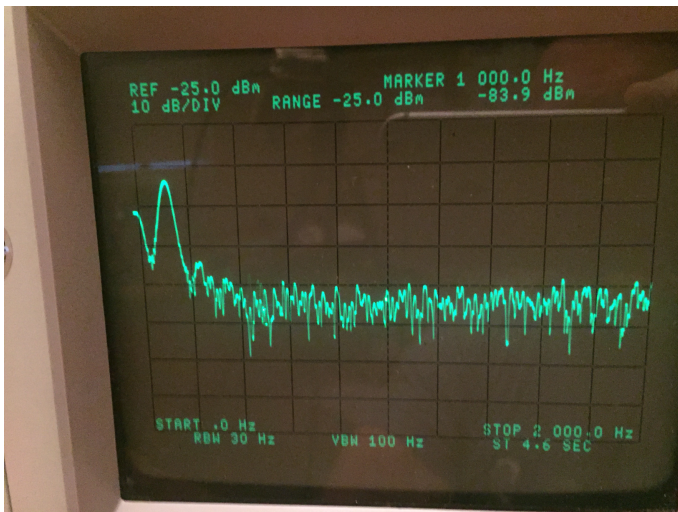
Frequency-domain Spectrum Analysis

There are two ways that physicists and signal-processors measure change: by time (above), or by frequency. A frequency display is like the mixer-board used in music studios, showing a graph with low frequencies (such as bass) at left, and higher ones (like treble) at right. Measurements were done with a Hewlett Packard 3585 Spectrum Analyzer, one of the most sophisticated every made.

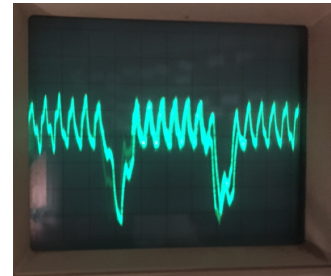
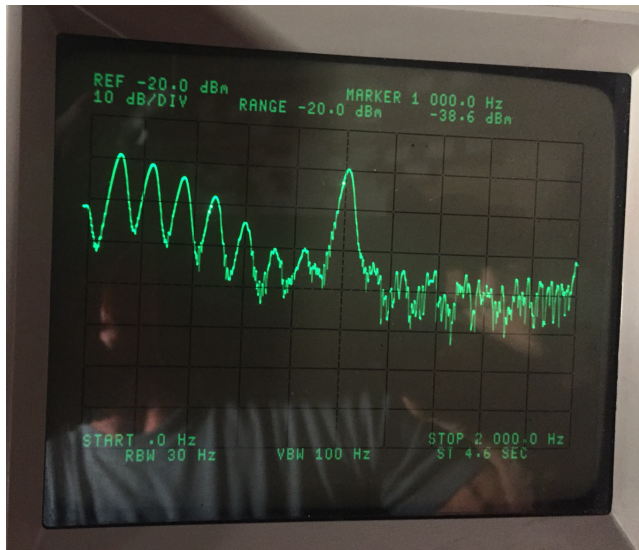
The frequency-spectrum graphs of those three light-sources are paired below with the time-domain trace from above:



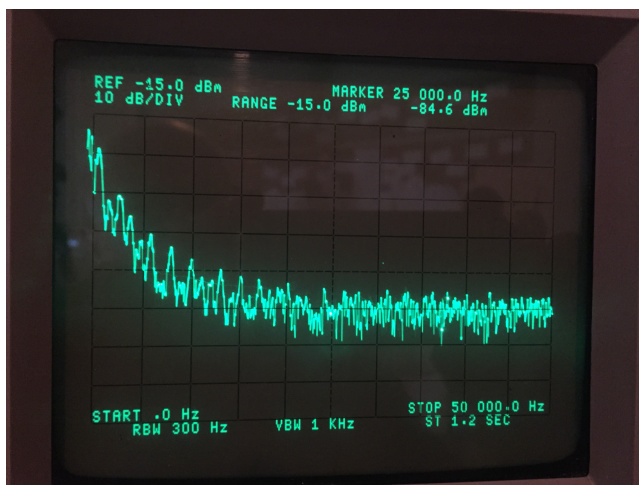
Frequency spectrum of sunlight (modest peak at about 5 kHz 100x weaker than DC peak plateau at far left)



Frequency spectrum of halogen work-light (prominent peak at 120Hz, the same frequency as the oscilloscope trace)

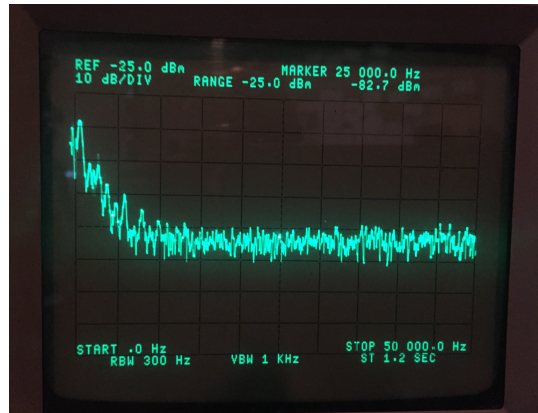
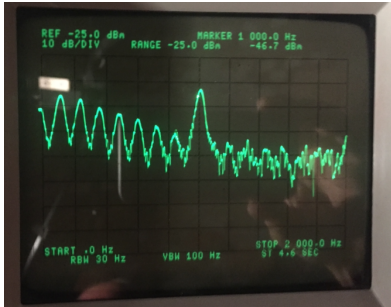


Frequency spectrum in green of LED can-light undimmed (the center peak at 1000 Hz corresponds to the fast sawtooth in the blue oscilloscope trace; the multiple peaks at 120Hz, 240 Hz, 360Hz come from the slower plateaus in the blue trace).



The spectrum is the same as above, but stretched out to a range fo 50 kHz at far right. You can see that this light produces frequency components up to about 10kHz, about five hundred times faster than we can notice.

Below are the same measurements on the same light, but now dimmed to about 50%, making the high-frequency parts even more prominent:



Frequency spectrum in green of LED can-light dimmed to 50%, with the 1000Hz peak even more prominent than the undimmed case.

Personalized Recommendations

You contracted us to examine the neuromechanical safety of your living room, dining room, and bedroom. Here are our findings:

Living room sound: Ambient sounds were modest in both amplitude and frequency, so nothing to worry about. Graphs attached.

Living room light: The dimmable ceiling can-lights “squealed” when dimmed with frequency components up to 50 kHz, and emit a shark’s-tooth of extra blue energy. We recommend replacing them to reduce eye-strain, headache, and anxiety.

Reading lights over chairs and sofa on the other hand, being true incandescent lights, exhibited neither problem.

Dining room sound: Ambient sounds were modest in both amplitude and frequency, so nothing to worry about. Graphs attached.

Dining room light: The dimmable ceiling can-lights “squealed” when dimmed with frequency components up to 50 kHz, and emit a shark’s-tooth of extra blue energy. We recommend replacing them to reduce eye-strain, headache, and anxiety.

Bedroom sound: Ironically the only irritating sound in the bedroom is the one intended to promote sleep, from the “white noise” generator. Since you use that noise to mask distractions from the street outside, we recommend at best using a truly natural (turbulent) noise generator like a babbling fountain. Next best would

be recordings (not synthesized imitations) of actual surf- or forest-sounds. Almost last would be pink noise, with white noise always avoided as an actual irritation.

Bedroom light: The only bad lights in the bedroom come from the TV screen, which irritates the eye and brain in more ways than one can list here, including flicker and color spectrum. We recommend removing it.