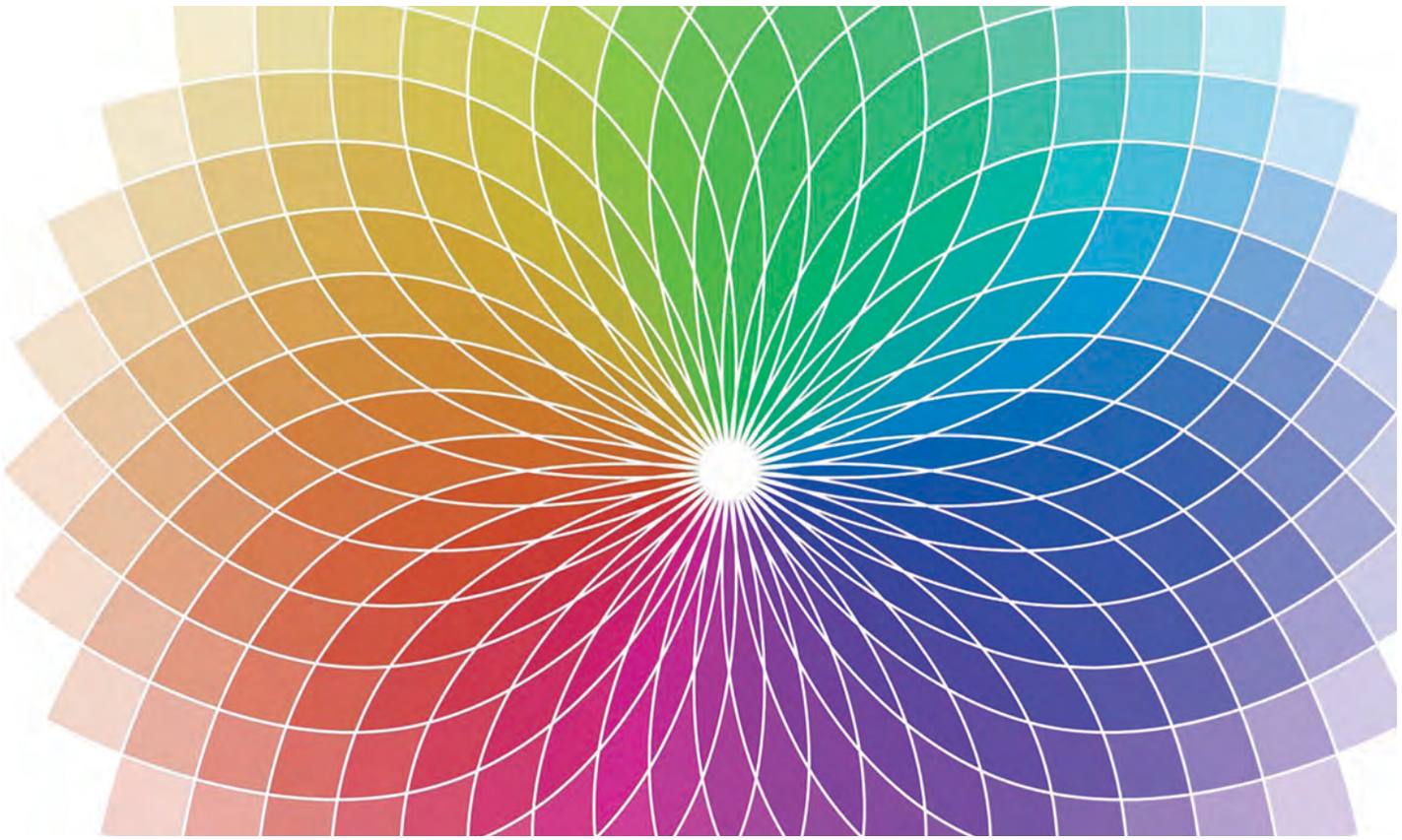
The Danger of Chromotherapy

Despite the lack of scientific evidence for its effectiveness and its use of esoteric theories to describe its mechanisms of action, chromotherapy has become popular. But is it safe?

SÉBASTIEN POINT



Chromotherapy, also known as color therapy, is a pseudomedicine based on a holistic approach and on a mixture of esoteric and scientific concepts. In a nutshell, it is the use of colored light applied on the skin or eyes to heal various health disorders, assuming some (scientifically undescribed) beneficial effects of color on body and mind. Traditionally, "color therapists" use white light sources to backlight colored filters. Nevertheless, driven by recent progress in solid-state lighting technologies, light-emitting diodes (LEDs) will probably become the most used light sources in chromotherapy. Some LED-based chromotherapy lamps are already available on the market. The main interest in LED lamps—in addition to their energy efficiency and long lifetime—is that they can provide various colors directly depending on the nature of the semiconductor inside without using any filter. Is the use of LEDs in chromotherapy without any risk?

Blue Light Hazard

In the last quarter of the twentieth century, the work of Ham, Mueller, and Sliney (Sliney et al. 1976; Ham and Mueller 1989) opened the way to the description of photochemical mechanisms of lesions on the retina during exposure to a blue light source. To prevent such damages, the International Commission on Non-Ionizing Radiation Protection (ICNIRP), in its "Guidelines on Limits of Exposure to Incoherent Visible and Infrared Radiation" (1989), defines a blue light action spectrum Bλ(λ) and exposure limits (expressed in radiance) that are used in *IEC 62471*, which is the standard when dealing with exposure to sources of broad spectrum incoherent optical radiations. The application of this standard is particularly justified for evaluating blue LED and white LED (also called White Phosphor Coated LED, or WPCLED, and made of a blue LED coated with phosphor), which combine high radiance and a blue-enhanced spectrum, as can be seen on Figure 1. In 2010, the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) published a collective expert report making an update on the blue light risk associated with the use of commercially available blue and white LEDs (Rapport de l'ANSES 2010). The results showed that it was possible to buy white or blue LEDs lamps reaching the medium risk group (RG2), potentially harmful to the retina of the eye if not diverted in 0.25 seconds.

In Europe, the design standards of lighting fixtures now include photobiological safety requirements based on standard *IEC 62471* or its application report *IEC TR 62778*. Scientific work is still ongoing to better understand mechanisms of blue light–induced damages and to improve prevention (Jaadane et al. 2015; Behar-Cohen et al. 2011), but current exposure limits seem to manage the risk for general lighting well.

Metrology

As noted, to evaluate and limit exposure to blue light, the ICNIRP has defined an action spectrum Bλ(λ) and a maximum permissible exposure value to short wavelengths. The maximum of the blue action spectrum occurs between 435 and 445 nm, which is close to the blue peak of blue LEDs or WPCLEDs, as we can see in Figure 2. The maximum permissible exposure to these wavelengths is 10^6 J / (m^2.sr).

The exposure H_b can be expressed as the product of a quantity called blue light effective radiance L_b by the exposition duration T. The knowledge of L_b allows classifying the measured lamp in one of the four risk groups defined by *IEC 62471* by comparison with some limits. Limits for L_b values are made according to exposition duration values so that H_b stays below 10^6 J / (m^2.sr). Naturally, the risk group increases as the duration required to exceed the permissible exposure decreases (see Table 1).

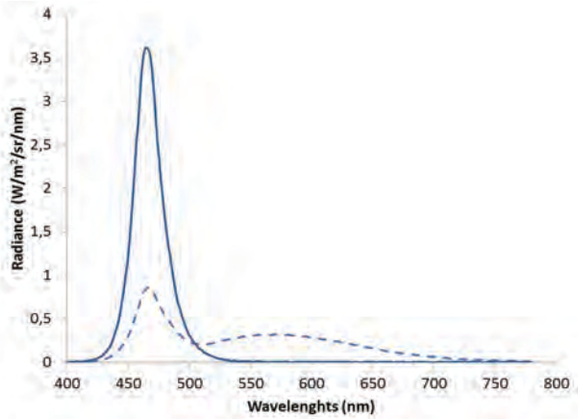


Figure 1: Spectrum of a blue LED (full line) and spectrum of the same LED after having superimposed a phosphor coat to produce white light (dotted line). Source: Sébastien Point.

When lamps or luminaires are measured and classified in RG2 and RG3, standard application report *IEC TR 62471-2* asks for some specific marking. That said, no specific marking is required for products classified in the no risk group (RG0) or low risk group (RG1), but that does not mean that the risk is absent in cases of inappropriate use, as for example in chromotherapy.

Chromotherapy Risks

Chromotherapy uses the (alleged) beneficial effects of color on the body and mind. There are generally said to be twelve "therapeutic" colors, but entering the keywords "chromotherapy" or "color therapy" in the bibliographic database of Alternative Therapies in Health and Medicine does not yield any medical research article that could help to understand their characteristics. Information available in the websites of color therapists does not provide a rigorous definition of the twelve colors claimed beneficial. However, this could have been easily done by giving a wavelength value for spectral color or by describing the spectral composition in the case of polychromatic radiation. Without this rigor in defining the colors, it seems very difficult to establish a repeatable protocol, as the physicist may have difficulty reproducing the color "lemon" (http://www.holistic-online.com/color/color_lemon.htm) or "strong pink" (http://unicorn-denmart.blog-

Table 1: Definition of risk groups depending on exposure duration (T) and Lb maximum values.

	RG0 (no risk group)	RG1 (low risk group)	RG2 (medium risk group)	RG3 (high risk group)
T (s)	10 000	100	0.25	<0.25
L_b max (w/m^2/sr)	<100	<10 000	<4 000 000	>4 000 000

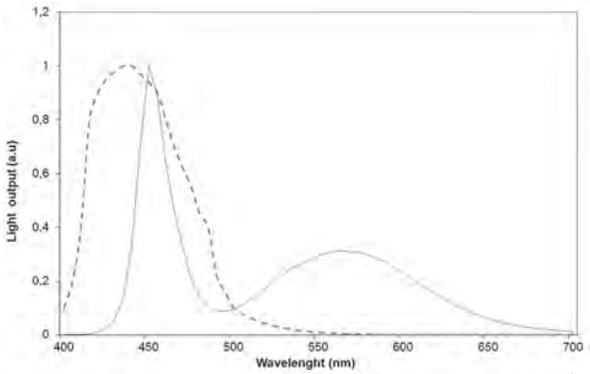


Figure 2: Spectrum of a WPCLED (full line) and action spectra Bλ(λ) (dotted line). Source: Sébastien Point.

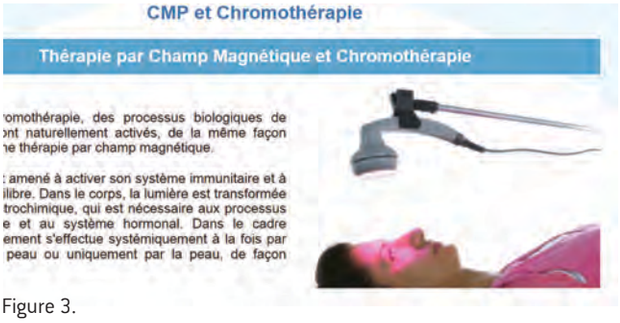


Figure 3.

Clearly, the color therapists do not trouble themselves with physics, scientific rigor, and evidence. Nevertheless, you can find many courses, seminars, and books, as well as many enthusiastic users and promoters. Indeed, as pseudomedicine, chromotherapy can be provided by a nonmedical professional in beauty or healthcare centers or even at home by individuals.

spot.com/2014/01/chromo-therapy-light-can-benefit-our.html). The lack of rigorous definition of colors and light sources disqualifies chromotherapy and is sufficient to refute the "scientific" character that some color therapists seek to fund their discipline.

Proponents usually associate these poorly defined colors with specific therapeutic effects on the body and on the mind. Of course, you could vainly search for a validated treatment protocol. Generally, the color is projected on the afflicted part of the subject, or on the eyes or even on the acupuncture points. The biological mechanisms for illuminated parts to see the color are not scientifically described, but therapists argue that "color therapy works on various energy points to help balance your body via the full spectrum of visible light, each color addressing a distinct need" (http://blog.sunlighten.com/chromotherapy-sauna-benefits-color-therapy-explained/).

In some variants of chromotherapy, colors are associated with "internal climatic energy" of the human body (heat, cold, moisture, dryness, wind) and would be capable of triggering a "climatic" opposite response from the body: for burns, for example, applying a red light (heat symbol) will supposedly cause an opposite response of the body (cold generation).

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As noted, light emitting diodes (LEDs) are already used in chromotherapy material and will probably become the primary light sources in coming years. Is it safe? Figure 3 shows an example of chromotherapy LED exposure as shown on the website of a chromotherapy lamp manufacturer. Notice that:

- The user's head is only few inches from the lamp, and there is no evidence that the head-lamp distance is under control.
- No eye protection is used.
- There is no evidence that exposure duration is under control.

There is naturally no evidence that chromotherapy is systematically or widely used in the way shown in Figure 3—but nor is there evidence it is used differently. This uncertainty raises a troubling question regarding the potential use of blue LEDs or WPCLEDs in a chromotherapy session. Even assuming that chromotherapy materials use only RG0 (no risk group) and RG1 (low risk group) LED bulbs, would the practice be safe so far without adapted eye protection and in conditions where distance and exposure duration are not under control? Lamps for chromotherapy cannot be considered as a source for general lighting service (GLS) as defined in *IEC 62471*. Lamps for chromotherapy must be seen as multipurpose lamps, as sunbed lamps, or as lamps for medical uses. As a consequence, L_b and risk groups for these kinds of lamps should be given for a 200 mm exposure distance. It is not unrealistic that users will place the light source only 200 mm from their eyes. In such a case, for an LED bulb whose L_b

would be between 100 and 10,000 W/m²/sr (range power of low risk group), maximum permissible exposure duration is between 100 seconds and 10,000 seconds, which covers many potential exposure situations. So permanent retinal damages from overexposure is possible if the user's eyes are voluntary exposed to a blue or white LED lamp of some thousands of W/m²/sr (RG1 without marking required) at a distance of 200 mm or less for a few minutes or more. With RG0 LED lamps, risk is lower but cannot be excluded either.

Conclusion

Although its promoters describe it as a rational scientific method, chromotherapy is a pseudomedicine, and consequently no real health benefits can be expected from it. On the other hand, there is some evidence that LEDs, even when classified in the no-risk or low-risk groups, can generate overexposure when critical parameters such as exposure distance and duration are not under control. We have good reason to believe that some users of LED-based chromotherapy material can not keep these parameters under control. For public safety, it is important that regulations or strong guidelines be put in place to supervise and control potentially dangerous practices such as chromotherapy.

References

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Sébastien Point is a French engineer and physicist who led some researches to develop mercury-free lamps and currently works in the lighting industry. He is a scientific rapporteur for blue light and vice president of the non-ionizing radiation section of the French radioprotection society, a member of French skeptics association AFIS and of the quarterly skeptic journal *Science & Pseudosciences.* His talks, in which he disassembles pseudoscientific practices, are available on the Internet.