

# **What is the ideal lamp color for photic stimulation?**

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## Introduction

Manufacturers of light and sound devices have almost exclusively used red light-emitting diodes because they are bright, inexpensive, and blood vessels in the eyelids pass red/orange light most efficiently. Typical red LED brightness in commercially available units is 400-1000 millicandela (mcd).

My original investigation into which light color to use also uncovered several papers<sup>1</sup> which showed increased 18 hz EEG activation during red light illumination.

I have located several papers which show that the effect of color on EEG is more subtle, and more complex, than I had originally realized. This information is briefly summarized below.

## Relationship between flicker color and optimal evoked response

Komatsu<sup>2</sup> has found that red light produces optimal EEG driving in the 17-18 Hz band. Green increased 15 Hz activity, while blue enhanced 10-13 Hz. White showed main peaks at 18-19 Hz. The populations studied were college undergraduates, and in this case the stimulation was

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<sup>1</sup> Summarized in Austin, Robert. *Shedding Light on Photic Driving*. Megabrain Report, Vol. 1 #2 n.d. (ca. 1991)

<sup>2</sup> Komatsu, Hiroshi. *Studies on the temporal frequency characteristics of vision by photic driving method: III. Temporal frequency characteristics of color vision*. Tohoku Psychologica Folia. 1987 vol. 46(1-4) 1-12.

delivered with the eyes open. In another study<sup>3</sup>, he found that yellow light would drive at either the red or green peak, or both.

Downing<sup>4</sup> has described similar results with his Lumatron<sup>tm</sup> research, with red light achieving maximum drive efficiency above 15 Hz, yellow at 13 Hz, green at 10.5 Hz, blue at 9 Hz, and indigo/violet in the theta and delta range.

More recently, we replicated multicolor stimulation using an RGB ganzfeld stimulator with similar results, although it appeared that there were fairly large individual differences<sup>5</sup>.

### Relationship between flicker color, driving response, and cognitive effects

It appears that the EEG driving effect of colored light varies also according to certain aspects of cognitive style. For example, Brown<sup>6</sup> found that the EEG frequency following response to red photic flicker was diminished in visualizers

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<sup>3</sup> Komatsu, Hiroshi *Studies on the temporal frequency characteristics of vision by photic driving method (IV): cone functions and resonance hypothesis. Tohoku Psychologica Folia 1991, vol 50 35-44.*

<sup>4</sup> Light Years Ahead, ed. Brian J. Brieling, Ph. D., Celestial Arts, Berkeley, CA 1996. See page 137 for a chart. This book is the record of a conference on the healing effects of color and light, and most chapters are by clinical psychologists. Also of interest are the sections on "brief strobic phototherapy" - the use of colored flicker in psychotherapy, with case studies.

<sup>5</sup> Unpublished research; to be posted to this website in the near future.

<sup>6</sup> Brown, Barbara B. *Specificity of EEG photic flicker responses to color as related to visual imagery Ability Psychophysiology 1966 vol 2 (3) 197-207*

but enhanced in non-visualizers<sup>7</sup>, while green and blue light had no such result. Vogel et. al.<sup>8</sup> found that "automatizers" (people who can quickly learn repetitive tasks) showed significantly lower levels of EEG following at all frequencies tested than "non-automatizers". The latter group showed substantial EEG amplitude driving, and responded to photic stimulation by either driving at the flicker frequency, or by showing increased alpha activity regardless of the driving frequency. The subjects were matched for age and IQ.

Colored light can produce significant effects on EEG activity even if it is not flickering. For example, Ali<sup>9</sup> showed that the alpha amplitude was suppressed substantially more in subjects exposed to red light than those exposed to blue. They hypothesize that red light generally increases vigilance.

Nyrke and Lang<sup>10</sup> showed that certain migraine patients exhibited greater tendency to photic driving at 16 - 22 Hz than controls, while several studies have shown that the probability of a seizure being triggered in photosensitives peaks at around 18 hz.

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<sup>7</sup> As you might expect, "visualizers" are those who tend to think visually, while "nonvisualizers" tend to think abstractly/verbally.

<sup>8</sup> Vogel, William et. al., *EEG Response to Photic Stimulation as a Function of Cognitive Style* Electroencephalography and Clinical Neurophysiology 1969, 27: 186-190

<sup>9</sup> Ali, M. R., *Pattern of EEG recovery under photic stimulation by light of different colors.* Electroencephalography and Clinical Neurophysiology 1972, 33: 332-335

<sup>10</sup> Nyrke, T; Lang, AH. *Spectral analysis of visual potentials evoked by sine wave modulated light in migraine.* Electroencephalography and Clinical Neurophysiology 1982 Apr; 53(4): 436-42.

## Discussion and conclusion.

Red light tends to increase EEG amplitude most efficiently at higher beta frequencies, and the color itself seems to increase vigilance. Its efficiency also varies as a function of certain aspects of cognitive style and ability to visualize. *It therefore appears to be the most appropriate color to use if beta stimulation and increased vigilance are the desired result.*

Conversely, in cases where the goal is to increase alpha and reduce vigilance (or increase the relaxation response), red is contraindicated. It appears that blue, green and yellow light are more effective in these contexts. Blue and green light LEDs of sufficient brightness to be useful are considerably more expensive than other colors at time (blue-filtered incandescent bulbs would be of similar cost).

Yellow (amber) LEDs are now available with sufficient brightness to produce significant EEG changes during eyes-closed stimulation. Tests at SynchroMed with bright amber light indicate that the perceived colors are "sunnier", "warmer", "friendlier" than red. Based upon this research, amber light would seem to be the ideal compromise color for systems with only single-color illumination. An additional benefit is that maximum EEG activation occurs at around 14 hz, the "peak performance" frequency being touted in the Neurofeedback community. For these reasons we have selected amber light as the ideal monochrome stimulation color.

Multicolor stimulators offer the maximum potential flexibility. As of this writing (2000) blue and green LEDs have now become available with sufficient brightness to be useful with eyes-closed stimulation. Synetic has developed a two-color system (Proteus) allowing considerable flexibility in mind-state stimulation, and is capable of smooth as well as abrupt transitions from one color to another. The system ships with red/green LiteFrames (with a warm amber being the midpoint between the two), but blue/green (sleep/deep relaxation) and red/blue LiteFrames will also be available.