# PWDAS-40

# THE BLUE RESPONSES IN PRESBYOPIA

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Some decades ago, when the incandescent lamps dominated interior lighting, including the working places, the *lampade azzurrate* were expected to favour the tasks involving fine visual work at small viewing distances, by suggesting that they could spare the accommodative effort, progressively reduced by incoming presbyopia.

The advent of computer facilities in drawing as well as the spread of cool fluorescent tubes, replaced the *lampade azzurrate*, to some extent at least. However nowadays these sources are widely requested by both laymen and professionists of every age. The list of ventilated advantages is very long. On the other hand we know that all general purpose incandescent lamps will be passed out. Thus the question is worth of re-examining

A similar situation occurred in the early thirties. Luckiesh and Moss (1931), after having carefully examined the problem, concluded that the superiority of the lamps rich of blue (re: bluish-white) was devoid of any scientific fundament. Nowadays the problem is still open, and gathering experimental data is encouraged.

It seems of interest to us to study how fully presbyopes, (healthy) old observers respond to stimuli relatively rich of blue in two situations currently met in everyday practice: either because of the characteristics of their spectral distribution of the reflectance of the used stimuli, or because being achromatic, they are lit by sources the SPD of which is richer of short wavelenghts, compared to the traditional tungsten filament incandescent ones (as it is the case of the *lampade azzurrate*)

The suggestions and proposals emerged from the research concerning the ventilated and debated superiority of blue, seem to predict that this superiority ceases to be valid for fully presbyopic very old observers, for instance, for the reasons listed below:

a) – The residual accommodation effort can be spared under incoming presbyopia in near vision tasks, by taking profit of the blue myopization consequence of chromatic eye aberration, but when the accommodation mechanism is totally inactive, like in full presbyopia, nothing can be spared

b) – The quality of retinal image is improved by pupil constriction, which, in turn is favoured by cooler lighting sources (Berman and Clear, 2008). But it becomes superfluous in the case of presbyopic people, characterized by senile miosis.

c) – The physiological yellowing of eye lens aggravates the attenuation of the flux of short wavelength light entering the pupil of very old people compared to the adults. The increased attenuation would be expected to minimize and even nullify the advantages of blue in full presbyopia.

d) – As age increases the senescence of the eye is accompanied by an increasing amount of a "physiological "acquired" tritan defect.

By accepting the challenge we studied the response to blue of three selected presbyopic observers aging, respectively, 71, 76 and 81 years who, during their life had been working in visual experiments with various involvements.

Our two experiments quoted below rely upon the fact that, as age increases, two facts persist: the sensitivity to blur and the eye depth of field. The latter is visualized by a range (along the optical axis of the eye) across which there is insensitivity to defocus. Now it has been shown by Ramsdale and Charman (1988) that the depth of field is not a "dead zone", because within it significant even if fine, "adjustment" effects may occur.

In Experiment I we consider the dependence of the sensitivity to blur (operatively produced with various degrees of defocus by placing a lens of variable power in front of the eye) . The test object consists of a square wave line (or stripe) grating of low spatial frequency, where a black stripe is alternated with a colored stripe. Binocular vision is employed. The target consists in assigning a score to the width (and spatial complexity) of the blurred zone at the border between two adjacent lines within the grating. The score is denoted by the symbol Sh and intends to describe how the sensation of sharpness increases as the border of the depth of field gradually approaches. That is, Sh is the step of a ten point internal scale, culminating with Sh = 10.

The main result is the inferiority of the Sh response to black and blue line grating compared to the other color combinations. It confirms the relative poor spatial responsivity of blue receptors. However, abruptly, ebtering the range of depth of focus, the blue-.balck grating appears as sharp and even sharper than those of other colors, when the defocus is small enough to render the local luminance contrast of the blue stripes sufficiently high (as it is probably the case in the neighbourhood of the best focus)

In Experiment II we record the speed of reading a text, consisting of passages ten line long, picked up from the pages of a book written in german language (the "third language" of our observers, thus forcing them to read completely every word). The reading time is recorded by using a stop watch. By varying the degree of defocus as in Experiment I, again we find the range of depth of focus, flanked by two escarpments. Now, we check that the depth of field is not a dead zone, and consists of a sequence of two bumps, on either side of its central point. The characteristics of this configuration differ when passing from incandescent lighting to the SPD of the *lampade azzurrate*.. The advantages of blue are evident. However, a word of caution is needed when calculating the difference between the plots obtained under either kind of source, because of some small (noisy) phase shifts and because of other possible "compensation" effects, adaptive in nature, described in the text.

In conclusion, the advantages of blue may be found even in fully presbyopic observers, at least in some particular conditions. The conflicting pro-and-contra, responsible for the doubtful expectations, lead to infer that the advantages cannot be ascribed to the traditional dioptric and physiological mechanisms. Rather, we should call into play the new views concerning the so-called S-pathway and its splitting into "imaging" and "non-imaging" pathways, in the higher brain centers, involving the "non P – cells".A field of advanced research, yet a matter of debates.