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Dips and bumps: On Bloch's law and the Broca-Sulzer phenomenon

Using the pretext of the potential benefit of their fundamental study in improving artificial lighting (with "impact on the billions of people"), Rieiro et al. (1) put forth an unfounded premise, a questionable "contradiction" between two well-known psychophysical phenomena, Bloch's law (2) and the Broca-Sulzer effect (3). The authors presented this premise to advance an equally implausible hypothesis, according to which this discrepancy could be the result of an unspecified mechanism that they have termed "intrinsic expertise bias," claimed to be present in Bloch's but not in Broca-Sulzer's measurements. Rieiro et al. (1) did not specify in which direction such bias is supposed to affect the measurements, the range in which it is supposed to operate, nor the basis of a differential effect between threshold (Bloch) and suprathreshold (Broca-Sulzer) conditions.

As it happens, of the (only) three reports cited as supportive of the supposed Bloch/Broca-Sulzer discrepancy, two (4, 5) in fact point to the effective equivalence of the two phenomena.

In referring to Bloch's law, Rieiro et al. (1) made two critical mistakes: they described it as an "appearance" (rather than "threshold") phenomenon and characterized this function as monotonic. The opposition of this supposed monotonicity to the nonmonotonicity of the Broca-Sulzer function is the alleged "contradiction" motivating the Rieiro et al. study (1).

Despite the fact that Bloch's and Broca-Sulzer's functions describe, respectively, the threshold and suprathreshold visual behavior over time, a unitary view of visual temporal processing implies that these two functions should be governed by the same integration process within the same system (i.e., with the same temporal impulse response, TIR). In general, suprathreshold appearance is known to be approximately proportional to one's sensitivity (i.e., the inverse of the intensity or contrast threshold). Thus, to the extent that the visual processing is linear with intensity, the sensitivity and appearance functions of stimulus duration should be strictly equivalent, either both being monotonic or both nonmonotonic. Accelerating or compressive nonlinearities could change their respective amplitudes but not their equivalence in form.

Moreover, contrary to the Rieiro et al. (1) account, a number of published datasets clearly display a "dip" in Bloch's function (see figure 1 in ref. 4), even though this observation has remained generally underappreciated. When such function is inverted about a vertical axis (so that the threshold becomes sensitivity), the dip becomes a "bump," just as for the Broca-Sulzer function. There is thus no discrepancy between the two domains. We have shown that the dip/bump results from the combination of a limited temporal integration window with a biphasic TIR at low spatial frequencies and that it disappears for higher spatial frequencies that yield a monophasic TIR (4).

Instead of the account of the discrepancy that Rieiro et al. (1) offered between their blocked and unblocked conditions (with only a 5% bump in the latter, far smaller than typically reported), it is much more plausible that this discrepancy was caused by sequential effects in their experimental procedure (all subjects having been run in the unblocked before the blocked condition, and all in the same sequence in the blocked condition).

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1 Rieiro H, et al. (2012) Optimizing the temporal dynamics of light to human perception. *Proc Natl Acad Sci USA* 109(48):19828–19833.
2 Bloch MA-M (1885) Expériences sur la vision. *Comptes Rendus de Séances de la Société de Biologie, Paris* 37:493–495.
3 Broca A, Sulzer D (1902) La sensation lumineuse en fonction du temps. *J Physiol (Paris)* 4:632.
4 Gorea A, Tyler CW (1986) New look at Bloch's law for contrast. *J Opt Soc Am A* 3(1):52–61.
5 Georgeson MA (1987) Temporal properties of spatial contrast vision. *Vision Res* 27(5):765–780.

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