Cortical mechanisms of object-centered lightness computation

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In a series of recent papers, I have proposed a cortical model of lightness computation. According to the model, local steps in log luminance are encoded by oriented spatial filters in early visual cortex (V1, V2), then spatially integrated along image paths directed towards the target at a subsequent cortical stage (Rudd, 2010, 2013, 2014). A contrast gain control mechanism adjusts each filter's gain on the basis of the outputs of other nearby filters. Top-down attentional modulation and edge classification also play roles in setting the early filter gain, in a way that depends on the subject's task and scene interpretation. The ON- and OFF-pathways from which the early filters are formed are assumed to have different inherent (preattentive) gains: the OFF-pathway gain being larger by a factor of ~3. The image paths along which filter outputs are integrated depend on figural organization. One path integration rule is to "compare target luminances to that of a common background region." This rule directly contradicts the highest luminance anchoring principle of Gilchrist's Anchoring Theory. I will discuss how my model accounts for quantitative data from experiments conducted with disk-annulus (Rudd & Zemach, 2004, 2005) and staircase-Gelb (Cataliotti & Glichrist, 1995) stimuli, as will experiments utilizing instructional manipulations (Arend & Spehar, 1993; Rudd, 2010), and the Phantom Illusion (Galmonte, Soranzo, Rudd, & Agostini, in press), in which either an incremental or decremental target surrounded by a shallow luminance gradients can be made to appear as an increment or decrement, depending on the gradient width. I will end with some informed speculation regarding the cortical areas involved in the various model computations. I suggest that long-range contrast integration involves processes located in and beyond cortical area V4, following midlevel cortical computations related to image segmentation (border completion, border ownership) in area V2.