A Neural Model of Lightness Anchoring

Domijan D

University of Rijeka, Croatia

Keywords: Anchoring, Computer Simulations, Staircase Gelb Effect, Lightness Perception, Neural Network

Lightness anchoring is a process of transformation of the scale of relative luminance ratios into an absolute scale of perceived lightness values. Recent psychophysical work suggests that lightness anchoring operates via maximum-as-white rule, that is, surface with highest luminance in the scene is anchored to the white and all other surfaces are anchored to different shades of gray depending on their luminance ratio relative to the white surface (Gilchrist et al., 1999). Illustration of this rule is the staircase Gelb effect where addition of a new surface with highest luminance alters the lightness appearance of all surfaces present in the scene. New surface appears as white and pushes all other surfaces to lower values on the scale of lightness values.

Goal of the present work is to provide mechanistic explanation of the lightness anchoring and staircase Gelb effect in particular. To this end, new neural network is developed and numerically tested. Proposed neural network consists of presynaptic inhibition of the feedforward input pathways and recurrent self-excitation. Presynaptic inhibition operates as a gate control which regulates the amount of lateral inhibition that a particular node can receive from other network locations. Consequence of the presynaptic inhibition is that the node which receives maximal input will not receive any lateral inhibition because its presynaptic inhibition will block all inhibitory signals arising from other nodes. Activity of this node will grow to the maximal level due to the self-excitation and this physiological maximum can be interpreted as a perception of white. On the other hand, nodes that receive less than maximal input will not be able to completely prevent lateral inhibition and their final activity level will be lower compared to the node with maximal level. Self-excitation is a necessary component of the model because it explains the compression of the scale of perceived lightness values.

Computer simulations showed that the proposed model correctly predicts the appearance of lightness values in staircase Gelb effect. Also, the model can simulate the effect of the surface size and the effect of insulation on lightness anchoring. However, the current version of the model cannot explain perception of luminosity, that is, perception of lightness values for sources of light and the effect of articulation on lightness anchoring.