Following the pioneering work of Gelb (1929), experimental work on the topic of lightness perception (i.e. the perceived reflectance of achromatic surfaces) has often entailed illuminating a small set of real-world surfaces within a spotlight—here referred to as "Gelb illumination." This technique has been presumed to isolate the surfaces with a unified "framework of illumination" and has been used to investigate the rules that the human visual system employs to map the range of actual physical surface reflectances in a visual scene to the range of perceived reflectances. Past work on the appearance of surfaces viewed under Gelb illumination has revealed the existence of systematic distortions in the physical-to-perceptual reflectance mapping (e.g. Fig. 1). These distortions have been analyzed in past work almost exclusively from the standpoint of lightness anchoring theory, a theory based on concepts taken from Gestalt psychology (i.e. grouping by illumination) to explain the distortions.

Here, I model data from two recent studies of the perceived reflectance of real surfaces viewed under Gelb illumination (Zavagno, Annan, & Caputo, 2004; Zavagno, Daneyko, & Liu, 2018) with a neurocomputational model of lightness perception (Rudd, 2010, 2017) that was originally developed to explain quantitative data from appearance matching experiments conducted with simple geometric displays (i.e. disks surrounded by annuli or squares surrounded by frames) presented on a computer monitor. I show that the neurocomputational model does a good job of explaining both qualitative and quantitative aspects of real-world surface perception.

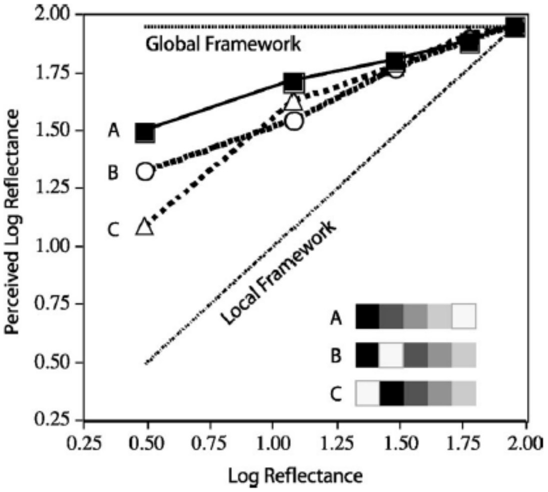

Fig 1. Lightness matches made to staircase-Gelb (Series A) scrambled Gelb (Series B & C) papers (from Zavagno, Annan, & Caputo, Vision, 2004).

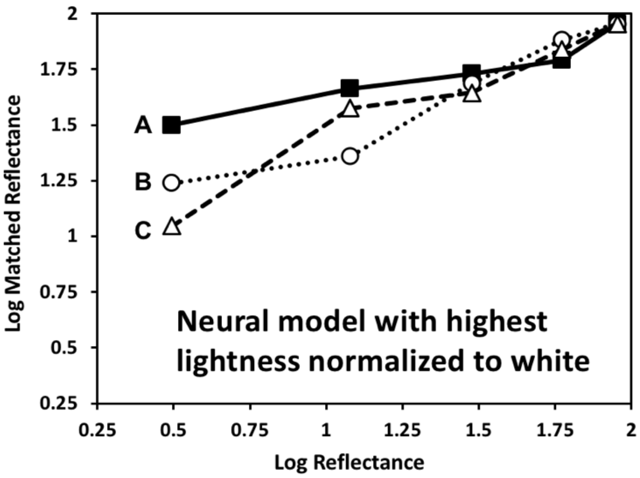

Fig 2. Simulated lightness matches based on the neural model.

Both data sets are here explained on the basis of the principle of edge integration: **log perceived reflectance = Sum (weighted steps in log luminance at surface borders)**. The edge weights are determined by the neural theory and are potentially different for incremental and decremental edges. To simulate the Zavagno et al. 2018 data, the integration occurs along a path that is normal to the orientation of the target borders. For the Zavagno et al., 2004 data, the integration occurs around the target periphery. I relate the edge weights to neural data on gain control in ON- and OFF-cells in the visual nervous system. This work extends my previous work on the model by articulating a new edge integration rule.