Separate normalization of ON / OFF channels is not enough to account for perceived brightness

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Goal

Improve quantitative predictions of image-computable models of brightness perception, by including asymmetric ON/OFF processing.

Perceived brightness scales nonlinearily with luminance in White’s effect

- White’s effect, range of target luminances
- Estimate perceptual scales (MLCM)
- Compressive for “in black”
- S-shaped for “in white”
- Meet at the extremes

Image-computable brightness model: FLODOG

1. Filter for contrast at different orientations, spatial scales:

2. Normalize each channel by similar & nearby channels:

3. Recombine normalized channel outputs:

4. Readout target “brightness” for range luminances:

Contrast polarity: asymmetry in ON vs. OFF pathways (increments vs. decrements)

Model detection, discrimination:

Edge-integration models:

Neurophysiological models:

Well-defined stimuli: with clear background, edges

Homuncular: explicit information about edges, background

Polarity-specific normalization is not enough

2. Split \( \pm \) into “ON” / “OFF” channels

3. Rectify “OFF” channel to positive values

4. Polarity-specific nonlinear normalization

How to separate ON / OFF in image-computable models?

Discussion

- Image-computable models can separate ON / OFF channels everywhere in arbitrary image, as sign of filter output
- Compared to most previous models: homuncular reasoning where model receives knowledge of contrast polarity, regions, in well-defined stimulus

- Asymmetric nonlinearity in ON / OFF channels not enough to predict perceptual brightness scales
- Shapes don’t match; scales don’t meet at extremes
- At least for White’s effect; compare with simultaneous contrast & assimilation effects

- Asymmetric processing of ON / OFF signals (positive / negative contrast) is candidate mechanism for explaining perceptual brightness scales
- Additional processing / normalization required

References
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6. Rudd et al. (2023)

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