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SHINE\_color: low-level control of colorful image properties

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Pupil dilation responses are used to investigate an array of cognitive abilities (REF) across the lifespan (REF). Whereas it is a versatile measure of high-level abilities, pupil dilation is also greatly affected by low-level properties of stimuli and experimental setting such as the luminance of visual stimuli, experimental room etc. (REF).

The SHINE toolbox is a powerful and easy to use set of functions that allow users to specify luminance and contrast, histogram, and Fourier amplitude spectra of visual stimuli (REF; Table 1). These parametric manipulations allow researchers to minimize potential low-level confounds when investigating higher-level processes (e.g., cognitive effort). However, it only works with greyscale images. Whereas this serves well to many research purposes (e.g., pupillometry BW REF), other research goals require colorful images (e.g., infant word learning REF). Here, we describe an adaptation of the SHINE toolbox (REF) that allow users to perform all operations from SHINE (i.e., …) with colorful images. The adaptation, dubbed SHINE\_color, builds on SHINE functions and add another N functions as well as the possibility to manipulate videos.

## Table 1 functions around here ##

The toolbox works in an intuitive way. Once downloaded, the user calls it in the command window of MATLAB by typing *SHINE\_color*. From there, the script guides the user through a series of questions that specify the input files characteristics and the operations to be performed (Figure 1). Once the parameters are defined, the provided RBG images are transformed to HSV images using the function *rgb2hsv* from the MATLAB image processing toolbox. If a video is provided, its’ frames are first extracted using the function *video2frames*, then each frame is transformed to HSV color space. The HSV color space separates Hue, Saturation, and Value (luminance) channels. Hue and Saturation are then hold in the computers’ memory and are not manipulated, but the Value channel (originally ranging from 0 to 1) is rescaled to match greyscale range (from 0 to 255). From this point forward, all functions from SHINE (i.e., N, N, N) can be applied to the Values channel, according to the users’ specification. Once the operations are performed, the Value channel rescaled to its’ original range (0-1), is combined with its’ original Hue and Saturation channels, and transformed back from HSV to RBG color space using the *hsv2rbg* function. For videos, the frames are recombined back into a video using the *frames2mpeg* function (Figure 1).

## Add Figure 1 around here ##

In addition, to quantify the change in luminance, the mean and standard deviation of each images’ Value channel is automatically calculated before and after manipulations using the function *lum\_calc*. The SHINE\_color toolbox is openly available at OSF (link) or GitHub (link). Plans for development include a guided user interface for users that are not familiar with MATLAB scripts, and an adaptation to Python language, for ready integration with experimental packages, such as PsychoPy (REF). The control of low-level properties of visual stimuli is an essential step for controlling low-level properties that might affect pupil dilation responses (REF). The SHINE\_color allow users to take full advantage of the powerful functions from the SHINE toolbox (REF) for controlling low-level properties of colorful images and videos.

**References**