

Frequency-Based Synesthetic Associations between Letters and Colors

Laura Herman^{1,2}, Jordan Suchow², George Alvarez²

¹Pine Crest School

²Vision Sciences Laboratory, Harvard University

(E-mail: laura.herman@pinecrest.edu)

Grapheme-color synesthesia is a form of synesthesia in which an individual's perception of numbers and letters is psychologically associated with colors. Synesthetes typically associate each letter with a specific color, but the cause of these pairings is unknown. However, one potentially useful clue is that the pairings appear to be consistent within a language, but different across languages. To determine the cause of these particular letter-color pairings, this study compares the frequency of letters in natural language with the wavelength of their associated colors across English, Spanish, and German speaking synesthetes. The frequency of a letter was highly correlated with the wavelength of its associated color ($r^2 \approx 0.7$). Frequent letters are typically more red and orange, while infrequent letters are typically blue or purple. Additionally, synesthetes show a tendency to associate more saturated colors with the most common letters ($r^2 \approx 0.2$), whereas the luminance of the colors is less correlated with letter frequency ($r^2 \approx 0.003$). Neurophysiologically, this pattern may be caused by the wavelength-specific color receptor neurons of visual area V4 being fused with the language processing neurons of the left middle temporal gyrus (LMTG) that perform semantic recognition. This fusion is theorized to be caused by a genetic mutation on the sixteenth chromosome. This account, when combined with the current data, suggests that this mutation causes V4 and LMTG neurons to fuse, and that a young synesthete's exposure to their native language guides the specific color associations that are formed as a result. Further, the impact of childhood exposure is evident in the correlation value for children's books letter frequency ($r^2 \approx 0.57$) rather than letter frequency in the Brown Corpus ($r^2 \approx 0.45$), a compilation of general exposure to the English language.