How synesthesia impacts working memory: A computational approach

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Abstract: Synesthesia is a fascinating condition in which an inducing stimulus (e.g., the letter "A") leads to the conscious perception of an additional sense (e.g., the color red). Color aids memory, and synesthesia has been linked to better-than-average memory. In this study, we investigate the impact of synesthesia on visual working memory. We hypothesized that the presence of color improves working memory as compared with achromatic stimuli. Furthermore, we explored whether synesthetic grapheme-color mappings, as compared with random grapheme-color mappings, provided additional working-memory benefits for graphemes. To do so, we expanded upon and integrated two computational models: First, we approximated the visual–temporal cortical activity of a synesthete's brain through emergent modeling of synesthesia-like crosstalk in a recurrent artificial neural network. We considered the output of this recurrent neural network as the emergent synesthetic grapheme-color mappings. Second, we used a neurobiologically-informed working memory model to compare how well the model could remember graphemes across the achromatic, emergent, and random grapheme-color conditions. As expected, we found that the presence of color improved working memory performance as compared with achromatic stimuli. For some stimulus sets, the emergent grapheme-color mappings led to significant improvements in working memory as compared with the random grapheme-color mappings. Interestingly, we observed that similar graphemes (Hamming distance) were mapped to similar colors in the recurrent neural network model, as in developmental synesthesia. This research illustrates how synesthetic mappings can support memory at a computational level, providing a mechanistic understanding of the neural basis of individual differences in cognitive abilities occurring in synesthesia.