Components of Attention in Synesthesia

Thomas Alrik Sørensen1,2, Maria Nordfang3, Michael Nygaard Pedersen2, Morten Storm Overgaard1,2, & Árni Gunnar Ásgeirsson3

1 Centre for Cognitive Neuroscience, Aalborg University
2 Cognitive Neuroscience Research Unit, Aarhus University
3 Center for Visual Cognition, University of Copenhagen

Abstract

One of the most common forms of synesthesia is between colors and graphemes (Colozzi, Murie, & Ross, 2012). Numerous studies have investigated different aspects of attention and synesthesia, e.g. effects of Stroop-like interference by colors that are incongruent with the synesthetic experience. Here we attempt to isolate how specific components of attention are affected by grapheme-color synesthesia. Eight carefully screened healthy participants with synesthesia reported the letters in briedly presented, post-masked arrays of letters and digits. On half the trials, the letters and digits were presented in colors congruent with the synesthetic experience. On the other half of the trials, the letters and digits were presented in colors that were incongruent with the synesthetic experience. Components of attention were estimated separately for congruent and incongruent trials by fitting the data to a mathematical model based on A Theory of Visual Attention (Bundesen, 1990). It has been previously been demonstrated that color experiences in observers with synesthesia are very stable over time, and that the color experience seems to be an integral part of the processing of letters, in for example grapheme-color synesthesia (Mattingley, 2005). Results from the present experiment show that synesthesia affects both speed of processing (C) and the capacity of visual short-term memory (K) is measured as the asymptote of fitted curve. Finally, the efficiency of selection (α) can be described as a ratio between targets and distractor elements.

Attention

To measure specific components of attention a Theory of Visual Attention (TVA; Bundesen, 1990) was used. Hereby we are able to estimate the threshold for visual perception (θ) at the intercept of the fitted curve on x. The speed of processing (C) is estimated by the slope of the tangent in θ, and the capacity of visual short-term memory (K) is measured as the asymptote of fitted curve. Finally, the efficiency of selection (α) can be described as a ratio between targets and distractor elements.

Synesthesia

Nine participants (19-39, 7 female) were screened using a screening tool inspired by Eagleman, Kagana, Nelson, Sagarnia, & Stares (2007), cutoff marked by the green line. Consistency was measures for both letters and numbers in each participant, and a subset of the most consistent letters (12) and numbers (6) was used in the experiment.

Results

The parameters of the nine color-grapheme observers in the congruent and incongruent trials showed that both processing speed and short-term memory capacity is affected by the two different conditions. Whereas both target selection efficiency and the threshold for visual perception remained unaffected by whether the stimuli was congruent with the synesthetic experience or not.

Conclusion

Observers with color-grapheme synesthesia both have a faster processing speed and a higher capacity for stimuli presented in a congruent compared to an incongruent condition. However, both the threshold for visual perception and the efficiency of target selection seem to be unaffected by a manipulation of stimulus congruence or incongruence. This indicates that a focus on the specific attentional components of synesthesia is important for understanding the mechanisms of color-grapheme synesthesia.