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Exploring the classical and numerical Delboeuf illusion: the impact of transcranial alternating current stimulation on magnitude processing

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Understanding cognitive and neural mechanisms underlying quantity processing is crucial for unraveling human cognition. The existence of a single magnitude system, encompassing non-symbolic number estimation alongside other magnitudes like time and space, is still highly debated since clear evidence is limited. Recent research examined whether spatial biases also influence numerosity judgments, using visual illusions like the Delboeuf illusion. While findings support a generalized magnitude system, direct comparisons of spatial and numerical Delboeuf illusions are missing. This study explored whether perceptual biases similarly affect different magnitude processing and whether transcranial alternating current stimulation (tACS) modulates these processes. Participants underwent three tACS conditions (seven Hz, 18 Hz, placebo) while performing tasks involving the classic and numerical Delboeuf illusions. We hypothesized that theta-frequency tACS (seven Hz) would enhance visual integration and illusion strength, while beta tACS (18 Hz) would reduce it by promoting visual segregation. Results indicated higher discrimination accuracy in area-based tasks than numerical judgments. Nonetheless, a significant correlation between performances in spatial and numerical illusions supported the existence of a shared mechanism for magnitude processing. Contrary to expectations, seven Hz tACS reduced the perceptual illusion's strength. No significant interaction emerged between tACS frequency and discrimination abilities. These findings deepen our understanding of the cognitive processes involved in magnitude perception, potentially supporting the hypothesis of a generalized magnitude system. They also highlight the potential and limitations of non-invasive brain stimulation techniques, such as tACS, in modulating perceptual processes, offering insights into the neural underpinnings of quantity perception.

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