Scene similarity space in the human brain

Thank you for participating in our study in the area of cognitive neuroscience. The goal of this study was to investigate the neural correlates of the representational similarity space of scenes in the human brain.

In daily life, the human visual system experiences numerous visual inputs from various visual environments. Such a large volume of visual information is assumed to be represented in a high-dimensional mental space, where individual dimensions correspond to different levels of visual features (e.g., from simple physical features such as color and orientation to complex semantic features such as naturalness and navigability). One important characteristic of this space is that it represents similar scenes in adjacent locations due to its geometrical nature. This concept has been called 'similarity space' in cognitive neuroscience, referring to the structure of neural representation that preserves the similarity of stimuli (Aguirre, 2007; Drucker & Aguirre, 2009).

To empirically find the neural evidence for the similarity space of scenes, we utilized a continuous scene image set generated from deep neural networks. In the MRI experiment, your brain activity was recorded while viewing these scene images in a pseudo-random order. In the following online experiment, you viewed the same set of scene images in pairs and rated the perceptual similarity of those images. To assess the relation between these different channels (brain vs. behavior), we leveraged the representational dissimilarity matrices (RDMs; Kriegeskorte et al., 2008), which abstracts the distinctive formats of each measurement into the same matrix format. With this method, we conveniently compare the RDMs from different measurements, evaluating the equivalence between the similarity space in human brains and behavioral judgments. In addition to your perceptual judgment, we also obtained the physical/categorical similarity matrices from image properties computed by AI and analyzed their equivalence. By doing so, we attempted to capture the neural similarity space that corresponds to multiple levels of similarity space embedded in the image space.

Completion of this study will inform how human brains represent complex real-world environments in an efficient format, the multi-dimensional similarity space. It will expand our understanding of the neural mechanism underlying scene perception. Also, technical aspects of our study will help validate AI-defined scene stimuli and apply the stimuli to various domains of neuroscience research.

If you have any questions, please contact Dr. Michael Mack at 416-978-4243 or by email at mack@psych.utoronto.ca.

Thanks for participating in our experiment!

References

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