

Encoding and decoding of cognitive functions

Shinji Nishimoto

Predictive modeling of brain activity has been used to reveal how the brain represents diverse perceptual phenomena, including visual, auditory, semantic, emotional, and linguistic experiences. These studies have provided the representational structure of perceptual contents, the macroscopic functional structure across the brain, and the quantitative frameworks to decode experiences from brain activity. However, many of these studies focused on passive experiences, and relatively little was known about how such studies might be generalized to explain more active cognitive experiences. Recently, we have extended the modeling approach to cognitive functions. We recorded brain activity while human participants performed 103 cognitive tasks, including audiovisual recognition, memory formation and recall, logical judgement, introspections, time perception, prediction, decisions on ethics and beauty, and motor controls. We built encoding and decoding models of the evoked brain activity using latent cognitive features. These models revealed internal structures and fine-scale cortical mappings of cognitive features and decoded brain activity that can be generalized even under novel tasks. Our framework provides a powerful step toward the comprehensive and quantitative understanding of human perceptual and cognitive experiences.