Decoding neural representations of human tool use from fMRI response patterns

ABSTRACT:

Tools are manipulable objects that, unlike other objects in the world, are tightly linked to highly predictable action procedures. Neuroimaging has revealed a left-lateralized tool network, but the exact role of specific regions remains unclear. Moreover, studies involving actual hand actions with 3D tools are rare as most research to date used visual stimuli (e.g., tool pictures) or action simulation (e.g., pantomime). Here we carried out functional magnetic resonance imaging (fMRI) studies and behavioural studies to investigate the neural representations of real hand actions towards 3D tools in the human brain. Using fMRI and multivoxel pattern analysis we show that regions of lateral occipital temporal cortex, intraparietal sulcus and anterior temporal lobe contain representations of how to typically grasp real tools. These findings demonstrate that, both dorsal and ventral visual stream regions contain representations of how to appropriately interact with tools which are automatically evoked in naïve participants even when they are irrelevant to task performance. We also carried out two behavioural experiments with 3D objects. We found that even when biomechanics are controlled for (such as object size), grip aperture is affected by typicality, tool identity and subsequent use. These studies demonstrate that even when structural differences between objects are carefully controlled for, early action kinematics reflect final action goals and anticipated end-states. Taken together our results suggest that actions with tools invoke a tight interplay between perception and action involving ventral and dorsal visual streams as well as semantic processing networks.

Keywords

fMRI, MVPA, Grasping, Tool use

Researcher's Contacts:

Dr. Stéphanie Rossit,
School of Psychology
0.107c Lawrence Stenhouse Building
University of East Anglia
Norwich Research Park
Norwich NR4 7TJ UK

Tel. +44 (0)160359 1674
Email: s.rossit@uea.ac.uk