Brain Plasticity Related to Psycho-motor Skills in Catheter-based Interventions

Katja Isabel Paul1,2, Fokie Cnossen2, Peter Lanzer3, Niels Taatgen2, Bernhard Sehm1 & Arno Villringer1

1Department of Neurology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany
2Institute of Artificial Intelligence and Cognitive Engineering, Faculty of Science and Engineering University of Groningen, The Netherlands
3Medical Center Bitterfeld, Germany
kpaul@cbs.mpg.de

Introduction

• A fascinating property of the human brain is its ability to reorganize as a result of experience
• Experimental evidence of practice-related brain change has been shown as a result of simple and increasingly complex visuo-motor training tasks, even after brief training periods

Previous studies examining brain plasticity related to complex visuo-motor skill training found:
• Increased grey matter volume in MT/V5 and (posterior) intraparietal sulcus
• Increased fractional anisotropy of white matter underlying the right posterior intraparietal sulcus
• Increased connectivity in fronto-parietal (and cerebellar networks

Catheter-based interventions (CBIs):
• Minimal access procedures, where a catheter is used to diagnose and/or treat the target site
• CBIs have many advantages over open procedures

Research questions and hypotheses:
Are there specific functional & structural neural changes after overall learning and do specific neural changes correlate with performance gain?

• Hypothesis: Specific training-related changes in MT/V5 and/or hippocampus, intraparietal sulcus & fronto-parietal networks are expected, the correlation with performance gains will be explored

Do structural and/or functional baseline MRI parameters predict learning of catheter-based interventions?

• Hypothesis: MT/V5 and intraparietal areas are expected to predict learning of CBIs

Methods

Participants:
• 2 groups (n= 40), healthy young medical students
• passed “Physikum”, no experience with CBIs
• Normal or corrected to normal vision, right-handed
• No MRI contraindications

Measures:
Cognitive
• Accuracy & reaction time in cognitive tasks (cognitive control, task-switching and visuo-spatial ability)
• Average amount of pegs inserted with the right hand in the manual dexterity task

Behavioural
• Total time required to complete the task
• Total fluoroscopy, cine time and contrast agent used to complete the task
• Number of catheter handling and table movement errors

Neuroanatomical
• Change in grey matter (T1-weighted scan)
• Change in white matter (diffusion weighted scan)
• Change in functional connectivity (resting-state fMRI)

Analysis:
• Region of interest analysis (MT/V5, hippocampus, intraparietal sulcus) as well as whole brain analysis

MRI scanning protocol:
• T1-weighted scan: MP2RAGE sequence
• Diffusion weighted imaging: multiband EPI sequence
• Resting state fMRI, multiband BOLD EPI-sequence

Day 1  Day 2  Day 3  Day 4  Day 5  Day 6  Day 7  Day 8
Training
Control group:
• Participants are age and gender matched to the experimental group
• Simplified training task on the simulator
• Participants also watch an instruction video, receive written instructions and perform the task under supervision

Procedure

MRI scanning protocol:
• T1-weighted scan: MP2RAGE sequence
• Diffusion weighted imaging: multiband EPI sequence
• Resting state fMRI, multiband BOLD EPI-sequence

Training on the catheter-lab simulator:
Aim: perform selective access to the right internal carotid artery
• Individual training for 2 hours on three consecutive days:
• Motor proficiency questionnaire
• Instruction video about the task & written instructions
• During the first trial, participants are walked through the procedure:
• On each training day, catheter-handling tips are given until selective access to the target artery is successfully performed once
• The training complexity advances as the training progresses
• Training complexity is defined by patient anatomy and morphology
• Control group:
• Participants are age and gender matched to the experimental group
• Simplified training task on the simulator
• Participants also watch an instruction video, receive written instructions and perform the task under supervision

References


