Neural plasticity resulting from task repetition is reduced in Multiple Sclerosis

Caroline A. Montojo1, Seema Sayala1, Amy L. Shelton1,2, Susan M. Courtney1,2,3

1Department of Psychological and Brain Sciences, Johns Hopkins University, 2Department of Neuroscience, Johns Hopkins University, 3F.M. Kirby Research Center for Functional Brain Imaging, Kennedy Krieger Institute

Introduction

• Task repetition in young healthy adults results in decreases in fMRI activation with maintained performance levels. This effect has been interpreted as reflecting increasing efficiency due to learning.

• Hallmark patterns of Multiple Sclerosis (MS) brain function during working memory (WM) tasks include:
  1. Greater fMRI activity within regions also activated by healthy adults, interpreted as reflecting a state of neural inefficiency.
  2. Additional brain regions active, interpreted as compensatory recruitment of additional neural resources, presumably through long-term functional reorganization.

• Previous studies averaged activity across entire scanning session.

Study aim: Test whether overall activity differences between MS patients and controls in WM tasks are related to differences in these normal, rapid, learning-related adaptations during task repetition.

Predictions

1. Changes occurring with task repetition:
   • Regions recruited by patients only
   • Regions recruited by controls only

2. Greater activity across all runs:
   • Patients
   • Controls

Participants

• 8 female relapsing-remitting MS patients
• 8 female healthy age-matched controls
• Average age: 38 years; Average disease duration: 7 years

Spatial WM Task: Trial Structure

Task Repetition: Scan Session Structure

S = spatial ("location") trials & control trials
O = object ("identity") trials & control trials

Results: Behavioral Performance

Spatial Task Accuracy

Results: Overall Activity Differences MS vs. Control

Analysis used to test for overall difference between groups (traditional group analysis):
ANOVA Factors:
• Group (Patient, Control)
• Repetition Run (2,3,4,5,6)
• Post-hoc contrast: Patient vs Control (collapsed across runs)

Results: Regions Showing Linear Trends for MS Patients or Controls

Analysis used to test for changes in activity occurring with task repetition:
ANOVA Factors:
• Group (Patient, Control)
• Repetition Run (2,3,4,5,6)
• Post-hoc contrast: Within-group linear trends

Results: Greater activity across all runs

Summary

• R supramarginal gyrus: MS patients show sustained activity while controls show task-related decreases
• R superior parietal lobule: MS patients show increasing activity while controls show no task-related modulation
• L superior frontal gyrus: MS patients show greater activity across all runs while controls show no task-related modulation

Conclusions

• Task repetition effects reveal three distinct mechanisms of altered brain activation in MS patients:
  1. Failure to improve neural efficiency with short-term task training
  2. Short-term compensatory processes, developing during task repetition
  3. Compensatory activation, developed either from long-term changes that occurred before scanning session or from immediate and sustained additional recruitment

References

This work was supported by NIMH grant SF1752-A1 and P01HS7 to S. Courtney and National Science Foundation Graduate Research Fellowship to C. Montojo.